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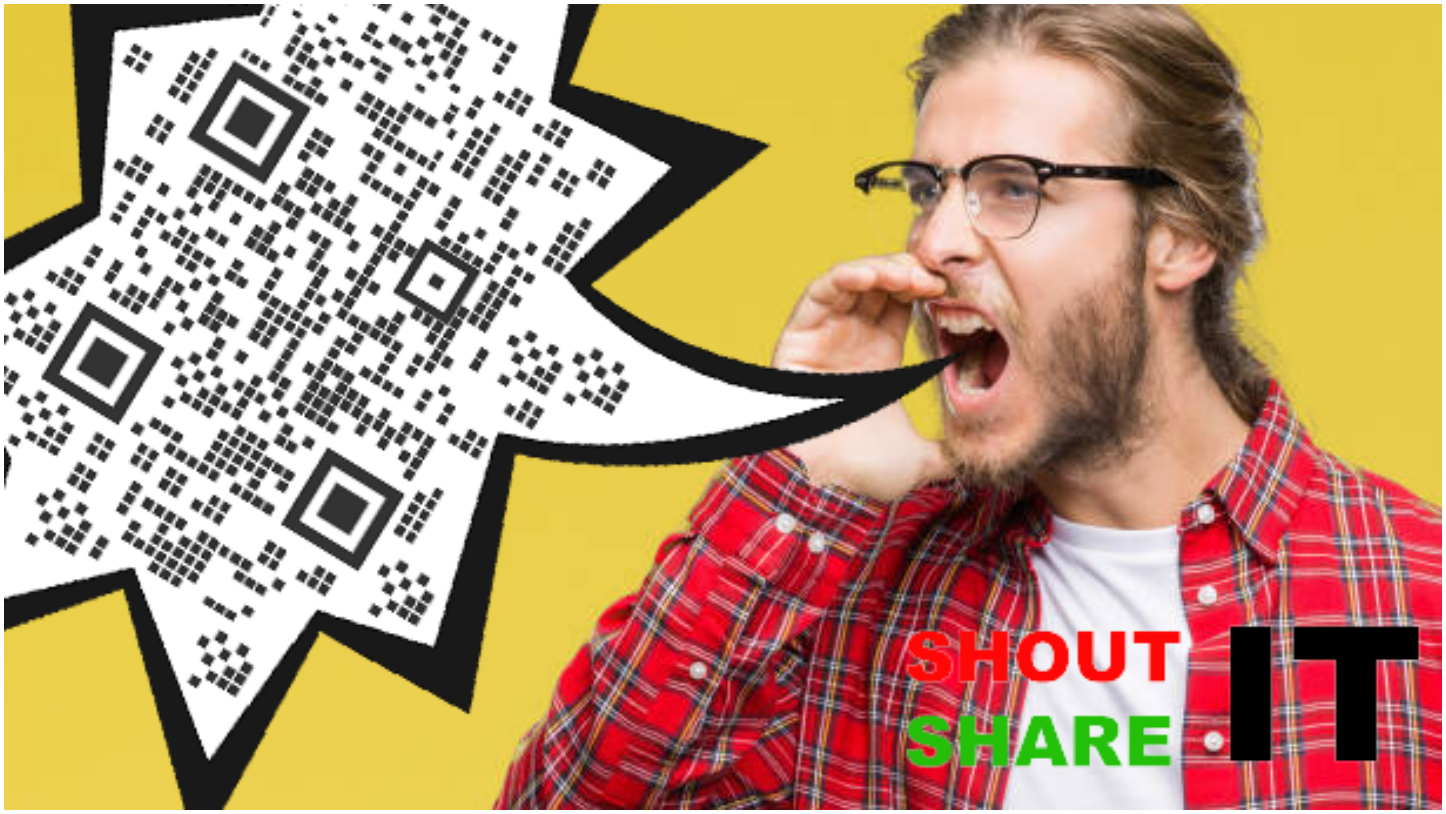
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REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY, 1933

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D.C., August 31, 1933.

SIR: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1933.

Respectfully,

PAUL G. REDINGTON, *Chief.*

Hon. HENRY A. WALLACE,
Secretary of Agriculture.

IMPORTANCE OF WILD-LIFE RESEARCH

Interrelationships of wild animals to their natural environment and to man can be properly evaluated only through the application of scientific principles developed by trained biologists. Research is therefore essential to the perpetuation of the harmless, interesting, or valuable species, and to imposing the right degree of restraint on those that would play havoc with human endeavor if left to increase in numbers unmolested. Throughout its 48 years' work the Bureau of Biological Survey has thus emphasized the importance of research. So long as there remain any remnants of wild life within the boundaries of the United States, and it is hoped that this will be forever, efficient management of the various species will be called for, as in the case of any other valuable natural resource, and to be efficient, wild-life management must have the fundamental basis of scientific research. Without research there can be no continued use and enjoyment of our native fauna, adoption of rational policies toward wild life, administration of protective laws, improvement in propagation of game and fur species, intelligent acquisition and maintenance of refuges for game and other birds and mammals, or dissemination of reliable information on any of these subjects.

The research conducted by the Bureau is concerned with the utility, geographic distribution, migrations, and relationships and classification of the various species in the native fauna; with their food, breeding, and other habits; with the nature of their diseases and the effects of these upon man and his domestic animals; with the food plants and other environment essential to refuge establishment; with methods of control of species that become a menace to farming, stock raising, game propagation, and forest and refuge administration; and with the relative abundance of waterfowl from year to year, including studies of causes of diminution, and development of measures to protect and conserve the various species.

Some of these lines of research have been continued from the beginnings of the Bureau; others have been added from time to time to meet changing conditions. Studies in methods of controlling injurious species and investigations relating to fur farming and game propagation, disease recognition, and where possible, remedial measures, have been extended and intensified; the same is true of research in the protection of the game, insectivorous, and other migratory birds that not only are valuable economically but serve to delight nature lovers and attract sportsmen to their haunts in proper season. All these more recent lines of study have had the benefit of fundamental research earlier undertaken.

EVENTS OF OUTSTANDING IMPORTANCE DURING THE YEAR

The following matters, most of which are commented upon in some detail in this report under appropriate sections concerning wild-life research, utilization, control, or protection, are regarded as outstandingly important in connection with the work of the Biological Survey during the past fiscal year:

Verification of reports that eelgrass had almost disappeared on the Atlantic coast, destroyed probably by a bacterial disease, with accompanying great reduction in the numbers of brant and, to a lesser degree, of other waterfowl.

Cooperative biological survey of areas across northern Mexico, to collect scientific specimens and data for correlating life-zone findings there and in southwestern United States.

Analysis of the contents of 4,116 coyote stomachs, constituting a material contribution toward a knowledge of the food habits of this predator, of value in determining control policies.

Completion of a 6-year intensive study of the life history, habits, and economic status of the elk in the Jackson Hole district of Wyoming.

Demonstration, through cooperative studies, of the prevalence of several infectious diseases that menace wild life, and of the importance of certain parasites of wild animals and birds in spreading bacterial and other diseases.

Determination of feed requirements for carrying rabbits through weekly periods from weaning to various marketing ages, and demonstration that these requirements compare favorably with those of other classes of livestock.

Suppression of a serious outbreak of rabies in predatory animals in southern New Mexico in an intensive 2-month campaign.

Furthering rodent control on national forests, by more than 1,500 Civilian Conservation Corps workers, and completion of plans under the Emergency Conservation Act for treating 1,650,000 rodent-infested acres on Indian reservations.

Organization of 312 county and community antirat campaigns in 21 States east of the Mississippi River, conducted at low cost to cooperating farmers and greatly reducing losses from rats in growing and stored products.

Establishment of a migratory-bird refuge including the Boulder Dam Project, by reservation of public lands by the President, and temporary withdrawal for further detailed investigation of public lands in Nevada for an additional refuge.

Institution of construction and other work for improving three eastern migratory-bird refuges by Civilian Conservation Corps camps.

Completion of field examinations of 141 migratory-bird refuge units, aggregating 3,710,927 acres in the 48 States, and the surveying, monumenting, and posting of 543 miles of bird-refuge boundaries and subsidiary lines.

Making the District of Columbia a game sanctuary, by act of July 14, 1932, under which it is unlawful to hunt or needlessly disturb waterfowl on any of the waters of the District.

Prescribing a 2-month open season for migratory waterfowl, closing the season on 2 species of ducks, reducing the daily bag and possession limits on 10 others, restricting to 25 the number of live-duck decoys that may be used, and reducing the bag limit on mourning doves to 18 a day.

More effective provision against entry of injurious foreign species of animals and birds, by revision of regulations, published by the Treasury Department in cooperation with the Department of Agriculture.

INVESTIGATIONS OF WILD-LIFE HABITS AND RELATIONSHIPS

BIOLOGICAL INVESTIGATIONS OF MIGRATORY BIRDS

PLIGHT OF WATERFOWL

The Biological Survey's studies of conditions affecting waterfowl in the United States and Canada were intensified when it became apparent that these game birds were passing through a critical period, because of drought, overhunting, and land settlement. Analyses of new data obtained, together with information gathered over a period of years, have enabled the Bureau to center attention upon features of vital importance to the birds. The field studies in gathering facts were the most extensive and carefully planned thus far undertaken and covered important regions on the breeding grounds, during fall and spring migrations, and on wintering areas along the Atlantic, Pacific, and Gulf coasts, and on inland waters.

Through culmination of generally unfavorable conditions, including overshooting and the cumulative effects of long-continued drought in many of the most important northwestern breeding areas, the waterfowl population reached the lowest point on record in 1931. In 1932, because of the reduced season and some improvements in breeding, the conditions appeared to warrant a season of 2 months. Although conditions in the spring of 1933 promised much improvement, the drought that prevailed in certain sections after the first of June seems to have offset any substantial promised gain, and the numbers of ducks cannot be held to have increased materially over those of 1931. Since that year marks the

lowest known point, the present status of waterfowl must be considered alarming and to warrant further restrictive measures.

The development of agriculture and industry during recent years has had a disastrous effect on waterfowl over immense areas, and the original conditions can never be restored. Species that have a wide breeding range and display a high degree of adaptability in selecting nesting sites and making use of new sources of food, including the grainfields of advancing agriculture, or are alert in escaping hunters, give greatest promise of survival in reasonable numbers. Human aid is called for, however, in the form of intelligent management of open seasons and bag limits, wider adoption of sportsmanlike practices, and more adequate provision of sanctuaries. Under present conditions enormous areas formerly important to the birds inevitably must be eliminated permanently from consideration as worth-while breeding range, and future conservation action must be guided accordingly. Much of the eliminated area lies within the comparatively restricted breeding range of some of the most highly prized waterfowl, including canvasback and redhead ducks. It is apparent that special effort in behalf of the birds must be made along constructive lines if they are to remain a measurable part of the attractive and valuable wild-life resources of the Nation. In other words, without better protection, some species may become extinct.

BANDING GAME AND OTHER BIRDS

Specific study of individual birds marked with numbered bands has continued to enlist the active interest and assistance of more than 1,800 cooperators and to yield results of scientific, educational, and administrative value. More than 250,000 birds of various species were thus marked during the year at trapping stations conducted by cooperators, and about 16,600 reports of birds that had been retaken were received by the Survey. Responses to inquiry indicate that at these banding stations equipment maintained without expense to the Department exceeds a value of $75,000, and that time and material valued at not less than $100,000 are contributed annually by station cooperators.

Owing to the importance of obtaining reliable data regarding game birds, special attention has been given to the operation of waterfowl-banding stations. Effort is made to carry on this work in regions from which definite information is needed regarding the migratory routes or sources of supply of game birds, and 50 such stations were operated in 20 States and 4 Canadian Provinces, extending from British Columbia, Washington, Oregon, and California east to Massachusetts, Maryland, and South Carolina. During the year 31,669 ducks and geese were banded, representing an increase of approximately 8,500 over last year. Significant data also were obtained regarding hand-reared mallards and black ducks that had been released in the wild and as to sex ratios in ducks.

In order to obtain adequate knowledge of their general habits, distribution, and migrations, much attention also was given to banding various gulls, terns, herons, crows, blackbirds, finches, and other species, which from time to time run counter to human interests and for which control measures are often demanded.

Through a plan of cooperation with the Austin Ornithological Research Station, on Cape Cod, Mass., unusual laboratory, trapping, and other equipment is available on a 700-acre sanctuary frequented by resident and migrant birds increasingly representative of the New England fauna. Approximately 47,000 individuals of a great variety have been banded at this station—20,000 during the past year, of which 1,200 were black ducks. Good results have been accomplished through systematic observation and through maintenance of nesting boxes and other means of increasing the attractiveness of the sanctuary. The resulting large increase in the numbers of ducks at the station was especially noticeable and proved a useful demonstration of the benefits that may accrue to a community maintaining bird sanctuaries. Over a long period during winter, rafts of ducks varying from 200 to 1,000 rested daily in the waters of the adjoining bay and on the neighboring flats. In the course of the work with ducks an obscure disease of the feet and mouth was noted, and arrangements were made for a cooperative study of its nature, the causative factors, and possible remedial measures.

LOCAL STUDIES OF BIRD DISTRIBUTION

Considerable field work was done in determining the distribution and abundance of the tricolored blackbird in California, where this species is of much concern to rice growers. Data were obtained also on the further spread of the European starling in the United States. At the request of the Louisiana Department of Conservation assistance was given in field work and in the preparation of a new report on the birds of that State. In addition, assistance was given individual orni-

thologists in the preparation of reports on the birds of Oregon, Utah, Wyoming, Iowa, Missouri, Indiana, Ohio, Virginia, North Carolina, and the Connecticut Valley in Massachusetts.

BIG-GAME RESEARCH

Investigation of the life history, habits, and relationships of the southern herd of elk in Wyoming, and of the factors affecting its welfare was concluded. The report prepared summarizes the results of previous work and sets forth accomplishments during the past 6 years. The feeding habits of elk in relation to livestock production are discussed, the feeding and breeding range, winter feeding, diseases and predators, and other features that relate to management practices, the welfare of the herd, and its recreational enjoyment, and use by man.

Incidentally, valuable information has been obtained regarding mountain sheep, moose, and other wild life of the Jackson Hole region and the Teton and Yellowstone National Parks areas. This investigation has been carried on in cooperation with the Forest Service and the Bureau of Plant Industry, of this Department, the National Park Service, of the Department of the Interior, the State Game Commission, and the University of Wyoming. It represents a notable advance in the modern trend to base wild-life administration on ascertained facts

A mimeographed leaflet (Bi-1274) on raising deer in captivity was issued during the year.

LIFE-ZONE INVESTIGATIONS

Under a plan of cooperation with the Museum of Comparative Zoology of Harvard University, whereby all traveling expenses were donated, a field naturalist of the Survey made a study of the animal life across northern Mexico adjacent to the United States. A valuable collection of rare and little-known mammals, birds, and reptiles was thus obtained, and information was gathered on the habits, distribution, abundance, and value of the mammals and birds and on the life zones in relation to those of the United States.

Field work in Georgia resulted in largely completing records of the distribution of breeding birds and mammals and working out boundaries of the life zones of that State. Similar work, required as a basis for a report on the mammals of Arizona, was carried to completion, and much preliminary work was accomplished on the identification of the animals that occur in that State. A report on the mammals of Oregon, completed during the year, is planned for publication in the North American Fauna series of the Bureau.

SCIENTIFIC REFERENCE COLLECTIONS AND RECORDS

A check-up was made of all specimens of deer available in the Biological Survey collection, the National Museum, and in the various museums of California, as a basis for a much-needed study of the deer of the Pacific coast region.

During the fiscal year, 844 mammal specimens were identified for 39 institutions and individuals in 25 States. Loans of 160 specimens were made to 10 institutions in 7 States and 1 foreign country. Three hundred and thirty-two mammal specimens were received for deposit in the collection. Members of the Survey staff described 23 mammals as new, and there were added to the Biological Survey collection 24 new type specimens, bringing the total to 854.

Field work chiefly in North Carolina, Georgia, and Virginia, and donations by cooperators have added 600 bird specimens to the reference collections. Approximately 1,000 birds were identified for individuals and cooperating scientific institutions, and extensive work was done in keeping identifications of the Biological Survey reference collections of birds in accord with recent systematic revisions and current usage. These collections now include more than 67,000 specimens. More than 95,000 records on migration and distribution of birds were added to the carded data.

FOREST WILD-LIFE RESEARCH

In the Lake States region, particular attention has been given to rabbits, which there are approaching a peak of abundance and now present serious problems in forest nurseries and reforestation areas, and in connection with disease conditions, which may affect quail, ruffed grouse, various fur bearers, and other wild life, as well as man. These problems are being studied by the Survey along broad lines in cooperation with the University of Minnesota, the State Conservation Commission, the State Agricultural Experiment Station, and the Lake States Forest Experiment Station. Poisoning methods were determined and demonstrated to

forest officials for use in protecting the seedlings and young trees from snowshoe and cottontail rabbits, and deterrent applications were tested to safeguard young trees from damage by rabbits and to protect planted seed against various seed-eating birds and mammals. As a necessary aid in the tree-planting program under the Emergency Conservation Act, the Forest Service has called upon the Survey to control the rabbits and thereby safeguard this large public investment.

In an effort to determine the extent to which the movements of rabbits are local or regional, which information has a direct bearing on control measures required in reforestation areas, about 2,000 were trapped and tagged. The results show that snowshoe rabbits commonly range between one eighth and one fourth mile, and the longest seasonal movement recorded was 2 miles. Cooperation was continued with the medical department of the University of Minnesota and the State Conservation Commission in the study of tularemia as it affects rabbits and other mammals, birds, and man.

Study of the behavior and feeding preferences of rabbits led to recommendation to foresters of the Superior National Forest area that the less frequented open spaces be planted during years of heavy infestation, leaving brushy lands for planting at times of rabbit scarcity, so that the small plants might attain sufficient height to escape serious damage before the next period of abundance.

The abundance and movements of mice and other small mammals in the various types of forest cover and soil were studied in the Appalachian, Lake States, and southwestern regions, and the effect upon the rodents of burning, clear cutting, and slash disposal. Experiments indicated that fires are not very effective in reducing the population of seed-eating mice, and that added protection provided by a ground cover of slash enables them to multiply rapidly and thus to interfere with natural reforestation and with seeding and planting efforts.

In Arizona, particular attention has been given to studies of the life history and relationships of wood rats, of the abundance of rabbits, and of the relation of rodents to Douglas-fir reproduction. A comprehensive and promising study of range conditions as affected by livestock and rodent grazing has been arranged under a cooperative plan between the Survey, the Forest Service, the University of Arizona, and the Carnegie Institution of Washington.

Game-management studies in the Appalachian area included the relationship of predators, especially the gray fox, to the game-bird population. Rapid increase of deer in the Pisgah National Forest during years of rigid protection developed a condition of overcrowding and overgrazing demanding intensive study, with a view to maintaining the herds on a sustained basis and at the same time permitting controlled hunting for food and recreation. At the request of the Forest Service, representatives of the Biological Survey joined in checking up results of the regulated hunting permitted in the fall of 1932. The hunting plan employed under direction and supervision of Forest Service officials proved a practical way of regulating overpopulation and providing for recreational and economic use of the surplus. Fully 90 percent of animals examined showed infestation by a roundworm (*Gongylonema* sp.) in the tongue and throat.

The experimental introduction of beavers into western North Carolina forests has met with success. The increase observed indicates that beavers should in time prove an important factor in regulating water run-off and under controlled trapping provide a valuable source of revenue from the skins.

Studies of the life histories, distribution, and abundance of both birds and mammals that are of primary importance in an investigation of the relations of wild life to forestry have been continued as in past years.

Assistance was given the Bureau of Entomology in determining in the Eastern States the role of rodents and other animals as hosts of the ticks that transmit spotted fever to man.

ALASKAN REINDEER INVESTIGATIONS

Investigational work was continued at the Survey's Reindeer Experiment Station at College, Alaska, in cooperation with the College of Agriculture and School of Mines, and along the Bering Sea coast and on Nunivak Island from the Bureau's substation at Nome. The investigations are designed through experiment and observation to determine proper methods of managing the grazing ranges and handling the reindeer. Gratifying success has attended the experiments at the station and on Nunivak Island in crossing reindeer and caribou. The crossbred fawns average distinctly larger at birth and have grown into superior animals in each age class. The increase in size runs from 50 to 100 pounds per animal in adult stock. Studies of the grazing ranges and feeding habits of the reindeer were continued as a basis for grazing allotments and herd management.

Analysis is being made of data assembled during the past 12 years to determine the grazing practices essential to maintenance of winter-forage production, which is one of the most critical problems in reindeer use of the range. A manuscript bringing to date the available information and recommendations on herd and range management has been completed for publication as a farmers' bulletin. Cooperation was continued with the Bureau of Animal Industry of this Department in a study of the food values to reindeer of Alaskan range forage, grain, and hay.

INTRODUCED MUSK OXEN

Of the 34 musk oxen introduced into Alaska in 1930, 29 remain and are in excellent condition. The animals are now 3 and 4 years old and have made satisfactory growth. The average fall weight of the older animals was 423 pounds for bulls and 392 pounds for cows; the average for the younger was 348 pounds for bulls and 340 pounds for cows. It has been demonstrated that musk oxen may be gentled and handled successfully in feed lot and pasture. The animals have proved to be good rustlers. In summer they feed on grass, sedge, and browse, and in winter they graze on dried grasses, particularly marsh grass and redtop, and browse on twigs of a number of shrubby plants. Feeding experiments have been continued with sedge hay, redtop, marsh grass, and other native forage, and with such cultivated crops as bromegrass, vetch, pea hay, and oat hay raised for this purpose on the college farm where yield and cost data were obtained. Analysis of materials obtained in connection with the various feeding tests were made in cooperation with the Department's Bureau of Animal Industry.

Experiments conducted by the Agricultural College resulted in the successful weaving of musk-ox wool in mixture with that of domestic sheep. Demonstrations by the College Extension Service in southeastern Alaska created a considerable demand for the wool for local manufacture of scarfs, socks, and jackets. The lightness, softness, and warmth of the garments are attractive features.

ECONOMIC INVESTIGATIONS OF WILD LIFE

FIELD INVESTIGATIONS OF INJURIOUS BIRDS

In studies of damage by birds in California and research in control methods, assistance was given to State horticultural commissioners and other cooperators. Methods were perfected for reducing losses from attacks of linnets and goldfinches on buds and fruits, and it was found that effective control could be obtained without appreciable mortality to other species. Tests of traps were carried on in an effort to devise a means of reducing damage by English and crowned sparrows to flower and garden seedlings, depredations that usually occur where poisoning is impracticable. Injury to rice by blackbirds remains a major problem, though by means of life-history studies and control tests the efficiency of repressive measures was improved.

Depredations on crops by migratory wild fowl continue to be serious. Studies were made of damage by mallards and other ducks to hog millet in Colorado, sorghum in Oklahoma, and corn in Nebraska and Idaho. In the case of federally protected game birds the problem is a vexing one. The birds themselves face so many destructive factors that they are in need of special protection, yet locally they sometimes concentrate in such great numbers as to do serious damage. The losses frequently fall on persons who derive no benefit from the presence of the wild fowl as game, and there is constant demand for reimbursement for losses, payments for which, however, are not authorized.

Upon investigation of a night-heron roost in a Massachusetts village, permit was issued for aggressive measures to dislodge the birds, which were creating a nuisance. A study of depredations by starlings on cherries and other fruits in New York State resulted in recommendation of control measures. Inspection of plantations of berry-bearing ornamentals in Oregon failed to corroborate charges of serious damage by birds, the latter not resorting much to the berries until after frost had softened them and rendered them unmarketable.

Investigation of damage to game fishes by cormorants on a Federal bird refuge in New Mexico did not disclose sufficient evidence to call for any change in policy as to bird protection on the refuge. Investigations were made also of the fall food habits of the great blue heron on the Upper Mississippi River Wild Life and Fish Refuge, and of gulls and other waterfowl in relation to smelt in the Columbia River. Study of the economic status of the white-necked raven was continued in Texas, work on the fish crow in relation to waterfowl nests was done in Maryland, and a report was completed on the injurious habits of the crested mynah, an introduced bird established in British Columbia not far from the United States boundary.

FIELD STUDIES OF THE FOOD OF MAMMALS

Investigation of the food of the Texas armadillo was continued to learn whether this animal is destructive to the eggs of quail and other ground-nesting birds. All the evidence was to the effect that the armadillo is not guilty and that skunks probably do most of the damage for which it is blamed. The general food habits of the armadillo are being studied, and indications are that it is so highly insectivorous that it will prove to be chiefly beneficial.

Two months were spent by one investigator in studying the food habits of predatory mammals in the field and in improving arrangements to insure a continuous flow of stomachs from predatory-animal control workers to the Food Habits Research Laboratory at Denver. In further studies of pocket gophers in southern California it was found that under the changed conditions brought about by irrigation, these destructive rodents are prolonging their breeding season. They are now known to reproduce during at least 9 months of the year. The relation of rodents to reforestation received attention in Washington State.

FOOD RESEARCH LABORATORY OPERATIONS

In the Denver Food Habits Research Laboratory there were examined 4,246 mammal stomachs, 4,116 of which were of coyotes, 73 of lynxes, and 33 of armadillos. Special effort was made to study all coyote material collected in fall months, and a report entitled "Autumn Food Habits of the Coyote" was read at the annual meeting of the American Society of Mammalogists and later published in that society's journal.

In the Washington laboratory more than 1,000 stomachs of birds, 775 of mammals, and 6 of reptiles, besides 679 owl and hawk pellets or similar indicators of food habits, were studied. As usual a great deal of this work was cooperative. Analyses for other divisions of the Survey included 604 stomachs of prairie dogs and pocket gophers and 20 of varying hares. For the southwestern quail investigation there were studied 70 stomachs of 3 species of quail, and 19 of hawks, owls, and mammals. Other stomachs analyzed included 65 of bobwhites, prairie chickens, and ravens for the Oklahoma quail and prairie-chicken experimental game-management projects, 85 in connection with a study of an unusual southward migration of sharp-tailed grouse in Ontario and Quebec, 79 of foxes and 29 of quail for the Virginia Commission of Game and Inland Fisheries, and 60 mammal stomachs, 20 mammal intestines, and 183 owl pellets for the Wisconsin quail investigation. These are only the more important instances of this type of work, a service in highly technical lines of investigation that cooperators and correspondents in general cannot do satisfactorily for themselves or get done elsewhere. Many identifications of wild-duck food plants and other material also were made for correspondents, as well as in connection with the Survey's own work.

The analysis of the contents of all stomachs of diving ducks on hand was completed, and considerable progress was made on the preparation of a new publication on propagation of wild-fowl food plants.

The reference collections, so indispensable for food-habits research, were steadily improved during the year, particularly by the addition of skeletal material and seeds. The seed collection in Washington at the end of the fiscal year comprised 4,271 species, representing 1,297 genera.

Among results of other laboratory activities may be mentioned revision of a manifolded leaflet (Bi-729) on magpie control, preparation of new leaflets on the food of the gray fox (Bi-1250), the food of the red fox (Bi-1251), and a preliminary report on the study of the raven's food (Bi-1281), besides three supplements to publications on attracting birds, dealing with fruit-bearing shrubs and trees useful to attract birds in the region from Oklahoma and Texas east to South Carolina and Florida. There was also reprinted for use in correspondence an extract entitled "Bird Allies of the Farmer", from a statement presented in November at the hearing before the Committee on Appropriations of the House of Representatives.

FOOD-HABITS RESEARCH IN FOREST WILD LIFE

Reports on investigations of birds in relation to the white pine blister rust and the white pine weevil were completed, and search was begun for a satisfactory site in New England on which to carry on cooperative study of forest wild-life management.

FOOD RESOURCES OF MIGRATORY WILD FOWL

The Biological Survey has given all possible attention to the serious shortage of eelgrass in relation to wild fowl. In four investigations along the Atlantic sea-

board it was found that brant had decreased enormously and Canada geese to a lesser extent, that the eelgrass was affected almost everywhere, had died out or been greatly reduced in many areas, but of late appeared to be recovering in the southern part of its range. Though it was demonstrated experimentally that the brant will respond to artificial feeding, constructive endeavors along this line or looking toward restoration of eelgrass have been impracticable on account of lack of funds.

Work on the food resources for wild fowl of Wisconsin covering several seasons (including the last) was summarized and a report prepared on the marsh and aquatic vegetation of Wisconsin and its value to wild fowl. Food-resource surveys of proposed Federal migratory-bird refuge sites were made in Florida, Louisiana, Ohio, Illinois, Nebraska, North Dakota, and South Dakota. Following similar studies, recommendations were made as to policy in the case of Federal refuges in Florida, Maryland, Nebraska, and North Dakota, as well as in that of a county game refuge in New York and a private refuge in Missouri. Somewhat extended surveys of waterfowl-feeding areas were made at the request of State officials in Maine and Connecticut, including in the latter case a study of the autumn food of the black duck in salt marshes.

Related work included study of alleged damage to wild-fowl food plants by effluents from a garbage-disposal works on the Potomac River; field investigation and court and commission testimony as to the effect on vegetation and wild life of the construction of dams in the upper Mississippi River; and study of flood-control works near Zanesville, Ohio. Inspection was made of Back Bay, Va., and upper Currituck Sound, N.C., for evidences of recovery of the water plants subsequent to restoration of a lock in the Albemarle and Chesapeake Canal to check pollution. At the close of the year there was unmistakable evidence of improvement.

STUDIES OF ENVIRONMENT FOR UPLAND GAME-BIRD PRODUCTION

Of the series of experimental quail-management projects, 2 were canceled by their sponsors during the year and 1 had not gotten properly started. There remain 7 in active operation—1 in Arkansas, 2 in Oklahoma, 1 in Indiana, 1 in North Carolina, and 2 in South Carolina. Although in some cases provisional arrangements were necessitated, all were regularly inspected. Three additional areas in Maryland and New Jersey suggested as sites for quail management were inspected but not recommended.

WILD-LIFE DISEASE INVESTIGATIONS

CYCLIC LOSSES IN THE WILD

For several years the seriousness of periodic disappearances of game and fur species has caused increasing concern among those interested in wild-life management. Since comparatively few forms of wild life can be propagated profitably under artificial conditions, increased effort is being made to stop the waste in the wild, where it occurs in more or less regular cycles, frequently almost wiping out the groups over large areas. Typical areas are being mapped and plans organized for a study of the fauna over a series of years—through at least one complete cycle, from the period of extreme scarcity through that of maximum density—and to seek the causes of the mortality. In the typical areas maintained under close observation during the past year some species are reaching such a peak of density that an outbreak of a virulent disease and a rapid decline may be expected at any time.

A number of animals recently collected have shown evidence of tularemia, and at the same time parasitic insects capable of spreading this and other infections have been plentiful. It has been demonstrated during the year that both the ruffed grouse and the sharp-tailed grouse are susceptible to tularemia in the wild. This knowledge is significant, as it now is evident that three of the most prominent game species—rabbits, quail, and grouse—may be victims of this disease in natural environment. These studies are conducted in greatest detail in Minnesota, and through the Bureau's cooperation special efforts have been made to correlate the disease findings in that State with those of other North American areas. With the necessary information concerning losses from disease epizootics and other causes, the investigators will develop all possible measures for reducing the extensiveness of these periodic disappearances of wild life.

Looking to the Survey for reliable information and assistance on the subject, State officials and individuals have repeatedly brought to the Bureau's attention situations involving waste of wild life through disease. Outside organizations

are evidencing an increasing desire to cooperate in checking such waste, and to this end several State institutions have offered formal agreements for joint efforts. The Survey should be able to take a more effective part in such cooperative programs when the financial situation improves sufficiently to warrant the necessary appropriation.

FUR-ANIMAL DISEASES

As limited facilities have prevented a thorough investigation of some of the more severe outbreaks of disease in fur-producing establishments, efforts have been devoted largely to investigation of a few pathological conditions that cause the heaviest losses. Progress has been made in a study of fox encephalitis, fox paratyphoid, and distemper. To meet in some measure the need for greater activity in field studies of fur-animal diseases, a fur breeders' organization of national scope has offered cooperation in the form of financial support for this type of investigation. Such aid will further the Bureau's work on fur-animal diseases conducted cooperatively with the University of Minnesota, which receives similar aid and donations of experimental animals directly from fox-farming sources.

Because fur farmers suppose that disease outbreaks on their ranches are started by unhealthy dogs and cats, research on the comparative diagnoses of definite infectious diseases of the two groups has been intensified.

Studies on parasite control on fur ranches have been continued, with special attention to the development of economical methods that do not involve individual treatment. The lungworm problem is a most serious parasitic menace. Following the recommendations of the Bureau, many fox ranchers have adopted the practice of constructing pens with wire-mesh floors or board floors elevated above the ground in such manner as to insure maximum protection against the animals coming in contact with the eggs of lungworms or the eggs or larvae of other parasites.

Progress has been made in studies of a digestive disease that causes a large part of the losses in commercial rabbitries. This is a form of colitis frequently associated with excessive bloating of the abdomen and is particularly disastrous among young stock. It is found not to be infectious, but probably related directly to feeding practices.

GAME-BIRD LOSSES

Through examination of large numbers of game birds a good understanding has been developed of various abnormalities affecting them. Under controlled conditions on game farms most of the losses were found to be due to ulcerative enteritis, entero-hepatitis, nutritional deficiencies, fowl pox, and respiratory infections. Parasitism by protozoans, nematodes, and cestodes has frequently been encountered on premises where necessary precautions have not been observed. It has been demonstrated cooperatively, however, that it is possible to keep flocks of some species of game birds practically free from any trace of parasitism and yet maintain their reproductive efficiency, by holding them in pens with wire-mesh floors raised above the ground.

References in earlier sections of this report have been made to an obscure disease observed in ducks during banding operations, to disease observations of the smaller forest fauna and deer, and to rodent and other hosts of the spotted-fever tick. A motion picture on the western duck sickness was completed during the year through cooperation between the Survey and the Department's Office of Motion Pictures.

LOSSES FROM WATER POLLUTION

Pollution of water frequented by migratory waterfowl during 1933 has been brought to the attention of the Biological Survey on a number of occasions, but even when the areas affected were extensive, the Bureau was without authority to take remedial action. Most reports of losses were localized, however, and were referable to State, municipal, or other authorities for attention.

FUR-PRODUCTION INVESTIGATIONS

SHORTAGE OF FUR ANIMALS ALARMING

The decline in the quantity of fur pelts of all kinds is causing uneasiness among fur merchants in the United States and Canada. Twenty years ago the periodic decreases could have been attributed to destruction of forests by ax and fire, indiscriminate drainage of swamp land, and encroachment of civilization. Although the recent development of automobile and airplane has ended the isolation that once afforded protection to fur animals, the constant decline during the

past decade is directly attributable to over-trapping and to the staging of so-called "vermin" campaigns for the purpose of destroying fur animals that obtain part of their sustenance from birds classed as game. Such activities have even been sponsored by State guardians of wild-life resources, who have placed statewide open seasons on highly valuable fur animals.

The present system of fur-animal conservation and protection has not proved effective. Better laws and stricter enforcement must be obtained without delay if the natural fur supply is to be restored. Though the responsibility of conserving and protecting fur animals as a natural resource rests chiefly with the States, the problem is national in its ramifications and the seriousness of the situation is such that a coordinated policy based on scientific findings should be established throughout the ranges of the several species of fur animals.

FUR-MARKET CONDITIONS

Conditions in the fur markets have shown steady improvement throughout the past year. The general wave of buying during June and July of 1933 advanced prices on the fur markets as much as 60 percent, with the average advance about 25 percent. Shippers and dealers are more optimistic than last year, and the fur industry is catching up on some of its back indebtedness and is liquidating large quantities of skins at a profit.

DEVELOPMENTS IN FUR FARMING

The fox farmers of the United States harvested 150,000 silver-fox skins during the 1933 season, and disposed of the bulk of them at prices that under prevailing conditions were considered fair. A European demand for American silver-fox skins saved the marketing boards and auction companies from disposing of pelts at ruinous prices. Financially the fur-farming industry has been in good shape and the average fur farmer has had no heavy encumbrances. Bank closings, however, created problems in financing the feeding and care of the young foxes that were to provide this year's crop of fur. The Biological Survey assisted fox farmers and their organizations in presenting their case to Governmental agencies as an enterprise justifying financial aid during the critical period. Fox farmers in general recognize that in improving methods of feeding and management they will reduce overhead expenses and thus be assured of increased profits.

RESEARCH IN FUR-ANIMAL PRODUCTION

The Biological Survey's research program on the production of fur animals, including rabbits, has been devoted primarily to measures for reducing operating costs by curtailing waste, lessening feeding and overhead expenses, and at the same time improving the quality of the product. Breeding-efficiency score cards have been perfected and applied toward selection of experimental animals, and the information has been passed on to fur farmers to enable them to select dependable breeding stock and thereby eliminate unsatisfactory producers. During the year the Survey issued a mimeographed leaflet (Bi-1235) on mink parasites, to acquaint producers with methods of prevention and control.

METHODS OF FUR STORAGE INVESTIGATED

Difference of opinion exists as to the merits of refrigeration as compared with fumigation for preserving dressed furs and fur garments. To obtain definite information as to the relative value of the two systems from the fur-preservation standpoint only, a cooperative experiment was inaugurated with 4 storage concerns handling furs in Washington, D.C., 2 of which use refrigeration, the other 2 fumigation. A number of dressed mink, muskrat, and rabbit pelts were placed in the vaults of each concern, and other kinds of fur will be added from time to time. The furs are being examined periodically to compare changes in color, sheen, and general appearance of fur or texture of skin. It is planned to prolong this experiment until the effects of fumigation and refrigeration on all dressed furs used commercially are thoroughly tested.

UNITED STATES FUR ANIMAL EXPERIMENT STATION

Experiments were conducted during the past year at the United States Fur Animal Experiment Station, Saratoga Springs, N.Y., to determine the value of meat byproducts as a substitute for raw meat in the diet of foxes. So far as growth and general health of pups and adults were concerned, no appreciable difference was noticed between the groups receiving the raw meat and those fed on the substitutes. Though foxes receiving raw meat made a slightly more

rapid growth of fur, the meat substitutes were economical and apparently satisfactory. All the diets, however, included some raw meat.

Three years of experimental work have demonstrated that exposing silver and black foxes to direct sunlight turns their fur brown before completion of full growth and primeness of skin. Foxes confined in cool, ventilated, and well-shaded furring sheds from early fall until pelting time show considerably less brown tinge than those kept in breeding pens in the direct sunlight. Since it is possible to produce fur of improved quality in sheds, their construction has been recommended.

Progress has been registered during the year in breeding experiments pertaining to color inheritance of foxes. The data obtained by the Survey, supplemented by information from individual fur farmers, indicate that inheritance of the three principal color phases in foxes—red, cross, and black—is undoubtedly controlled by two unit factors. It is evident that there were at one time two distinctly black mutations of the red fox, one of which, probably in foxes inhabiting the eastern part of Canada, is represented by the standard-bred type of black (silver) fox; the other probably in a native of Alaska, or of the northwestern region of Canada, is represented by the Alaskan black (silver) fox. Biometrical analysis of data reveals only a single-factor difference between homozygous (breeding true to type) red and homozygous standard black and also only a single-factor difference between homozygous red and homozygous Alaskan black. Red is strongly dominant over standard black but shows no noteworthy dominance over Alaskan black. The first generation from a crossing of Alaskan black and pure red foxes shows the cross type of pelt. Indications are that the double recessive genotype apparently is a black (silver) fox. Further investigations are necessary before results of this breeding problem can be definitely reported.

To reduce losses among foxes by accidents in climbing and also to make it unnecessary to provide fox pens with woven-wire floors to prevent digging, the Fur Animal Experiment Station has continued the practice of lancing the branches of the deep flexor tendons in the front feet. This operation has been performed on foxes by fur farmers for a number of years, but it is found that the utmost precaution must be taken not to sever the branches of the tendon too high, thereby causing lameness and a condition commonly known in livestock as "broken down pasterns." One year after being operated upon, some of the animals have resumed their digging proclivities to a marked degree. Toe nails of foxes operated upon are not kept worn down, thus making trimming necessary.

Confining foxes in pens with elevated wire floors has proved to be effective in preventing lungworms, and of value also in treating disease-infested foxes. Vixens not extremely nervous and known to be good mothers were moved to pens with elevated wire floors shortly after mating. The pups were raised successfully, with no lungworm infestation, as long as they were kept on these floors. After being moved to infested ground they were soon infested. Elevated wire-floored pens of sufficient size and proper design give promise of extensive commercial use on ranches where the lungworm problem is serious.

In experiments conducted during the year in polygamous mating of foxes it has been found by microscopic examination of vaginal smears that unobserved matings can be detected. This should make it possible to undertake polygamous mating more extensively and thus reduce the number of males ordinarily required for service. Similar work at the Canadian Governmental Fox Ranch on Prince Edward Island corroborates the Bureau's experience.

CONDITIONS IN RABBIT RAISING

The general decrease in meat prices extended also to rabbit meat, though curtailment of highly promotional rabbit-production schemes has enabled the industry gradually to get on a more substantial basis. The Federal Trade Commission and the better-business bureaus have effectively cooperated with the Bureau of Biological Survey in efforts to abolish misrepresentations and other unfair practices. Federal authorities have closed a number of rabbit enterprises because of such practices, and others have failed or gone into bankruptcy. Many apparently desirable market outlets were thus lost to rabbit breeders, but in their stead a decidedly increased market for the rabbit meat itself has been developed, which is a healthy indication for the future of the industry. Though the market price has been materially lower, the actual cash sales have been much higher, and the rabbit business in the United States is now on a sounder basis than at any previous time. One eastern packing house has entered into a cooperative agreement with a State rabbit breeders' association to kill and prepare for market its entire production under Federal inspection.

UNITED STATES RABBIT EXPERIMENT STATION

During the year all but two of the experiments at the United States Rabbit Experiment Station, Fontana, Calif., that had been carried on for a 1- or 2-year period, were completed. Part of the data has been summarized. Two years' work shows that in well-balanced liberal rations the addition of cod-liver oil or yeast neither increased the gain in young rabbits up to marketing age, at 60 days, nor reduced the feed consumption. In these experiments the feed supplied per breeding doe per year was 108 pounds of mixed concentrates, 225 pounds of alfalfa hay, and a small quantity of green feed. The average doe produced in 1 year 63 pounds of marketable young rabbits. The average number of young raised per doe to weaning age was 19.4. The average number of litters kindled per doe was 4.11, of which each doe raised to weaning age 3.7 litters. Perhaps the most significant data are those showing the feed requirements of doe and young for the production of 100 pounds of live rabbit at 60 days of age. This feed totaled 152 pounds of mixed concentrates, 316 pounds of alfalfa hay, and a little green feed. Thus, the feed requirements compare favorably with those of other classes of livestock. During the year a complete new group of experiments was instituted from which should be developed exact and extensive information on rabbit feeding. Most of these are to run 2 years.

The cooperative work with the University of California on the morphological and physiological study of the growth and development of skin and hair has resulted in a fairly complete series of slides for each day of the latter part of the rabbit's embryonic period and during the postnatal period.

The Bureau's work in experimental rabbit production was explained at numerous rabbit-breeders' meetings in various parts of the country and at the convention of the American Rabbit and Cavy Breeders Association, held in Pittsburgh, Pa., in November. Mimeographed leaflets on rabbit breeding (Bi-1243) and on the Survey's work for rabbit raisers (Bi-1279) were issued during the year, and a manuscript for a new bulletin on rabbit raising was practically completed.

MUSKRAT INVESTIGATIONS IN NATURAL HABITAT

Investigational work at Church Creek, Md., conducted during the past year by the Bureau in cooperation with the University of Maryland and the game division of the State Conservation Department, has developed valuable new information on muskrats. During the 1932 breeding season 16 litters, totaling 47, were produced in pens, an average of 2.9 young per litter. This is a greater number than in the previous year, and more of the young reached maturity. Definite experiments were started to determine by controlled matings the exact period of gestation, which preliminary reports indicate is approximately 29 days.

A careful survey of the various foods that muskrats relish on the marsh showed that 21 kinds of plants were eaten as well as blue crabs, salt-water mussels, and turtles. The important plants were three-square bulrush, saltmarsh bulrush, broadleaf cattail, narrowleaf cattail, wild reed, and saltgrass.

At the close of the year plans were completed for transferring, with the aid of a camp of the Civilian Conservation Corps, the muskrat experimental work to the Blackwater Migratory Bird Refuge, Md., much more extensive and satisfactory equipment being there available.

Pelts of muskrats trapped during the year are being sent to the Washington office at regular intervals by protectors of some of the Federal wild-life refuges. They are then examined and graded by fur experts and forwarded to the raw-fur market for further grading and valuation. These investigations are being conducted to establish definitely the prime-fur period of muskrats on the various refuges, so that the fur crop may be harvested when at its greatest market value. It is planned to conduct similar investigations on the refuges to establish prime-fur periods on other fur animals.

CONTROL OF PREDATORY ANIMALS AND INJURIOUS RODENTS

COOPERATION DURING DEPRESSION PERIOD

Reduced expenditures by county, State, and Federal Governments have resulted in some curtailment of control of predatory animals and injurious rodents. Farmers, ranchers, and stockmen, however, have continued to support the work liberally, often, in spite of their financial distress, making up for the deficiency of public funds by private contributions, recognizing that protection of stock and maximum profits are needed more in hard times than during prosperity.

Federal and cooperative funds permitted field work in 42 States during the fiscal year. Federal funds expended totaled $547,499, of which $31,479 was used

in control-methods research; $288,957 in the control of predatory animals; and $227,063 in the control of rodents and other small-animal pests. The 42 cooperating States provided $370,794. In addition, counties, livestock associations, and individuals, pursuant to cooperative agreements, provided $641,785 for labor and materials in control campaigns.

CONTROL-METHODS RESEARCH

Research in improved methods of controlling injurious animals was continued, and excellent progress was made on major problems. Numerous experiments have been made with fumigants and poisons to develop less expensive and more effective control methods than those now in use. Studies also have been made of repellents designed to drive away certain injurious animals rather than kill them.

CRAWFISHES

Progress has been made in developing a method of controlling crawfishes, which are troublesome in parts of Alabama and Mississippi. These crustaceans make burrows from 1½ to 14 feet deep in the black soil found there, and at night they come out and cut off the young growing corn, cotton, and alfalfa plants. There are from 2,000 to 14,500 burrows per acre, and often the damage is so severe and prolonged that it is necessary to replant the crops 2 or 3 times. A Bureau investigator spent 3 months in cooperation with State officials working on control methods, and substantial progress is being made in the development of agents of control.

BAT ROOSTS

Hundreds of requests are received each year for information on controlling bats, which become obnoxious in dwellings when they congregate to roost in attics, double walls, and other enclosed places. An effective method of control has been developed by Bureau workers, using naphthalene in either flake or moth-ball form, which serves as a repellent strong enough to drive them from the roosting sites. As soon as they have been driven out, the entrance is blocked and the entire colony is forced to seek new quarters. The Bureau recommends the use of repellents wherever possible, and resorts to the use of poisonous gases only when other methods fail.

RODENT BAITS

A new formula was developed for preparing strychnine grain baits that promises to increase efficiency and lower the cost of rodent control. This will be tested thoroughly and released to the operational forces as soon as perfected. Special studies have been made of liquid red-squill extracts to supplement the powdered squill now used in cooperative campaigns against rats. It has been found that increased efficiency results from changing the type of baits for clean-up work following campaigns.

Field and laboratory studies of the effect of thallium on vegetation indicate that heavy concentrations of the metal will kill growing plants, but that these show no injurious effects whatever from the quantities used in rodent baits. A test plot was selected upon which there was a definite record of nine different applications of thallium-treated baits on an area that had been kept denuded of vegetation by ground squirrels. After the rodents were killed the bare spot produced natural vegetation fully as tall and vigorous as on areas not so disturbed. The presence of the baits had in no way injured the fertility of the soil.

Studies were continued of antidotes for thallium, strychnine, and cyanide, and some progress has been made. A short paper on Recent Developments in the Preparation and Uses of Thallium was prepared by James C. Munch, consulting pharmacologist of the Survey, and published during the year in an outside journal, and the same author has prepared for publication by the American Medical Association a paper entitled "Human Thallotoxicosis", a detailed description of the unfortunate human poisoning by thallium in California, referred to in last year's report. That the quantity of poison per bait is being constantly reduced was set forth in an article published in the 1932 Yearbook of Agriculture under the title "Rodent Control Studies Develop Specific Methods for Different Species", which during the past year was reprinted and issued in separate form (Yearbook separate 1342).

STUDIES OF COYOTE RANGING

To gather more definite information on the natural drift of coyotes, 24 animals were tagged and released. From 7 of these returns have been received—4 were

caught within 5 months in the immediate vicinity of the place where tagged; 2 were taken 13 months later, one 10 miles away, the other 100 miles; and 1 was taken 8 months after release, 55 miles distant. The coyotes had been tagged and released in localities where their movements would not be influenced by the shifting of livestock between lower and higher regions. An authentic record was obtained of a wolf that in 2 weeks had traveled a distance of 125 miles, crossing 4 mountain ranges.

CONTROL OF PREDATORY ANIMALS

PROBLEMS SERIOUS WITH REDUCED FORCES

In spite of a decrease of 20 percent in funds available for the control of predatory animals, there has been an increase of 4.81 percent in the number taken by the cooperative hunter force during the past year. During the fiscal year a total of 63,045 predatory animals were taken by Federal, State, and other cooperative hunters working under the supervision of the Biological Survey. This number consisted of 54,942 coyotes, 1,227 wolves, 249 mountain lions, 6,382 bobcats and lynxes, and 245 stock-killing bears.

The low price of furs has in many places resulted in a practical cessation of activity by commercial trappers, who in normal times get a goodly proportion of the annual take. In many sections these men constitute a first line of defense against the ravages of predators, leaving to the Federal, State, and other cooperative hunters the task of trapping areas of light infestation and capturing killers that have become trap shy.

With the falling off in appropriations, fewer hunters were employed, leaving greatly increased areas to be covered by each trapper to keep depredations on livestock to the minimum. This heavy burden has necessarily caused more than normal delay in taking care of complaints of damage. Fortunately, however, the public has realized the difficulties of the situation and has shown creditable forbearance in criticism.

The normal increase of coyotes being rapid, constant warfare is necessary to hold them in check. The average number of young per litter is at least six, and larger litters are common. A Federal hunter recently trapped a female coyote near Kanosh, Utah, carrying 17 unborn young, the largest number of which there is an authentic record. In Colorado another coyote was captured in March carrying 12 unborn young, while litters of 13 and 14 have been previously recorded.

The ability of coyotes to adapt themselves to new conditions was instanced when a Federal hunter located a coyote den in a culvert beneath the tracks of an electric railroad at Hollydale, Calif., over which the cars run regularly about every 10 minutes. The den was only about 50 yards from an inhabited house and close to a boulevard on which hundreds of people travel daily. The fecundity of these animals, coupled with their remarkable adaptive ability, makes control work a real problem. The slackening of activity by commercial trappers and the dropping of cooperative hunters, through shortage of funds, will call for greatly increased activity later on to reduce again the coyote population.

To insure that field practices in control in widely scattered operations shall be in accord with Bureau policies, detailed instructions in the form of a manual, for administrative use only and not for public distribution, were printed and issued during the year to all hunters engaged in predatory-animal control under Bureau supervision. In addition regional supervisors have been in constant touch with district leaders and hunters, and field inspections have been made by members of the headquarters staff at Washington.

SUPPRESSION OF RABIES

One of the most serious outbreaks of rabies in several years recently occurred among coyotes in southern New Mexico and was extended by them into western Texas and eastern Arizona. The malady originated in southern Lea County, near Eunice, N.Mex., in February, and within a month had assumed serious proportions. Many ranchers reported that cattle and dogs were bitten by rabid coyotes and that coyotes were frequently seen in corrals and yards. In one case 18 of 22 sheep bitten by coyotes showed symptoms of rabies and were killed by the owner. Several bulls held in a feed lot were attacked by a rabid coyote, but recovered after being given serum treatment. A milk cow at Mesquite, N.Mex., developed rabies, and an entire family that had been using its raw milk was given Pasteur treatment. One trapper bitten by a rabid coyote also received treatment, and another, attacked by a coyote, killed the animal before it could bite him.

Bureau leaders and hunters in New Mexico instituted a vigorous control campaign in cooperation with the Public Health Service, of the Department of the Interior, the State Public Health Laboratory, the Mescalero Indian Agency, the Extension Service and the Forest Service, of the Department of Agriculture, and the New Mexico College of Agriculture and Mechanic Arts. Extensive trap and poison lines were established, and strict quarantine measures against dogs were adopted on the Mescalero Indian Reservation and elsewhere. After 2 months of intensive work, the rabies outbreak appeared to be well under control.

Another serious outbreak of rabies occurred in Nevada, during which 23 head of cattle died of the disease in Paradise Valley. Although herds of cattle on feed lots at the time were exposed to attack, prompt measures taken to stamp out the disease prevented further serious losses. During the year five positive cases of rabies in coyotes in Nevada were found on laboratory analysis.

GAME DESTRUCTION BY PREDATORS

Mountain lions, coyotes, and other predatory animals continue to be a serious menace to valuable game animals in many sections of the country. The Forest Service recently estimated that from 1927 to 1931, predators killed 505,693 animals on national forests, more than 100,000 a year, including losses among cattle, horses, sheep, and goats in 1930 and 1931. Another estimate for the calendar year 1932 shows that almost twice as many deer were killed in the national forests of California by predatory animals as by hunters. Predatory animals were estimated to have killed 27,611 deer during the year, while hunters during the open season killed only 14,408. The supervisor of the Sierra National Forest reported during the hunting season 42 cases in which coyotes were seen chasing deer. In Colorado, there were recorded three eye-witness reports of coyotes killing deer.

To supplement its series of leaflets on trapping coyotes, wolves, bobcats, and other predators, the Bureau during the year issued Leaflet No. 94, Hints on Mountain-lion Trapping, giving suggestions to the general public on controlling these larger cats where they menace livestock or game.

CONTROL OF RODENTS

Though rodent-control work decreased during the fiscal year 1933, in many areas the reduction was not serious because previous control campaigns had reduced the numbers of rodents to a point where only clean-up and patrol work was necessary. Intensive control measures have been continued on productive lands, but marginal areas have been neglected during the period of financial depression. Warnings to orchardists for the protection of trees from damage by field mice were issued during the winter by means of statements issued to the newspapers.

The acreage treated in Federal and cooperative work for the control of prairie dogs, ground squirrels, pocket gophers, jack rabbits, field mice, kangaroo rats, woodchucks, and other small rodents, was 20,702,451, and the total cost, $855,560. The saving estimated by 82,087 cooperators was $5,025,458.

EXTENT OF LOSSES FROM RODENTS

The damage that may be caused by rodents is illustrated by an incident that occurred in western Nebraska. Pocket gophers burrowed into the bank of a main canal in a large irrigated district and caused a break that resulted in water shortage on 65,000 acres of farm land and a deep deposit of silt on an additional 100 acres. The total damage, including $13,000 for prompt repairs of the break, was estimated at $50,000. At the request of water users, the Survey's leader of rodent control in the district later organized a small crew and carried on pocket-gopher control along 85 miles of ditch bank at a cost of approximately $1,000.

A member of the Utah State Board of Agriculture estimated that in Sanpete County a campaign for the control of ground squirrels conducted under the supervision of the Bureau resulted in the saving of enough forage to feed 6,000 sheep for 1 year. In this county the saving in alfalfa, oats, wheat, and other grains approximated $12,000 to $14,000 while the saving for one county on all crops was estimated at $25,000.

A large proportion of farms, perhaps 75 percent, or 4,650,000 farms in the United States are confronted with a rat problem. According to estimates of 6,000 farmers, the annual loss per farm from rat depredations approximates $40. If this applies to all the affected farms in the United States, farmers are losing $186,000,000 each year from this one destructive pest.

ANTIRAT CAMPAIGNS

During the year, 312 antirat campaigns, organized on county-wide or community-wide bases, in 21 States east of the Mississippi River, were sponsored by the Biological Survey and carried on under the supervision of Bureau leaders and county agents. In these campaigns 126,507 pounds of red-squill baits were used, 112,333 of which were mixed and canned at the bait-mixing station maintained by cooperators at Barnstable, Mass. Use of canned baits greatly simplifies control procedure, since the cooperators have only to open the cans and expose the ready-mixed baits on the eve of the county-wide campaign. These 312 campaigns cost cooperators less than $40,000, an average cost to each farmer of about 50 cents.

In parts of Texas where typhus fever has been spread from infected rats by fleas, mites, and body lice, rat-control operations were continued. An instructive pamphlet issued by the Texas State Department of Health discussed symptoms of the disease, the role of the rat as a carrier, and the reported cases by months since 1924. It emphasized the necessity of cooperative antirat campaigns such as those conducted by the Survey.

A report from Navasota, Tex., indicates that cats may also be carriers of typhus fever. The health authorities learned that one kitten of a certain litter was given to a nurse, who shortly afterward contracted typhus fever; two others were given to a family in the town, some members of which within a short time thereafter became ill with the disease; another of the litter was sent to a person in Long View, Tex., and this person also soon afterward became ill.

PORCUPINES

Porcupine control was continued in forested areas in the Western States, especially in Arizona, California, Idaho, Utah, and Oregon, and also in Pennsylvania. These rodents are destructive to growing trees, and their control has been difficult. Improvements made in control technic should go far toward developing a successful method.

On the Coconino National Forest, Ariz., where the Bureau has carried on extensive control operations in cooperation with the Forest Service, the Office of Motion Pictures recently filmed scenes showing the damage by porcupines and methods developed for control.

COTTON RATS

The intensive campaign for the control of cotton rats carried on during 1932 in one county in Florida, at a cost of less than $600, reduced by 90 percent the losses to truck crops, which local reports indicate had previously amounted to $150,000 a year. The methods of control adopted in that campaign were continued and the area treated has been extended to include several new counties, where like results have been obtained. Truck growers throughout the area report that the methods adopted have yielded excellent results and that the damage from cotton rats this year has been of little consequence.

WOODCHUCKS

The success of antirat campaigns, in which baits are distributed to cooperators at low cost and wide areas are covered simultaneously, has suggested use of the same plan for controlling woodchucks. Fourteen county agents in the East accordingly scheduled cooperative campaigns, during which 2,596 pounds of calcium cyanide were used, a quantity sufficient to treat more than 30,000 woodchuck burrows. Arrangements were made with a large manufacturing company to supply the cyanide at cost and to pack it in convenient-sized containers. The whole procedure was similar to that for the rat campaigns, and in spite of the economic conditions, all county agents found the cooperators responsive to the plan. Excellent results were obtained.

BAIT-MIXING STATION

The cooperative bait-mixing station, established by the Survey in temporary quarters at McCammon, Idaho, in 1927, has recently been moved to Pocatello, Idaho, and installed in a substantially constructed, reasonably fireproof structure. The new building has trackage facilities for loading and unloading car-lot shipments, and is provided with storage space for 1½ million pounds of grain.

Oats purchased for the processing of poisoned bait are of the highest quality. First thoroughly cleaned to remove weed seeds and broken and immature kernels, they are then steamed and rolled so that each kernel is exposed to the poison

treatment. Great care is used in the cleaning, to prevent the spread of noxious weeds and to safeguard birds that might pick up cracked kernels or weed seeds. Generally, rodents prefer the plump kernels. During the year the mixing station processed and shipped to cooperators in 25 States, principally in the West, 734,650 pounds of prepared bait, 262,888 pounds of steam-crushed oats, and 750 gallons of paste for the preparation of woodchuck and rabbit baits. To meet the demand for prepared baits for the rodent-control operations under the President's Emergency Conservation Work program, the Idaho plant operated 16 to 24 hours a day for a period of about 6 weeks, and during this time prepared more than a half million pounds of grain baits.

EMERGENCY CONSERVATION PROGRAM

The President's Emergency Conservation Work program offered an opportunity for the long-needed control of rodents on national forests and Indian reservations, and rodent control was made one of the projects. Under the new program, lands on national forests and Indian reservations will be improved by the elimination of rodents, and marginal areas that have long served as breeding grounds from which adjacent cleared lands privately owned have continually been reinfested will be cleaned up.

Work on national forests was begun early in May, but nothing was done on Indian reservations before June 30 other than to formulate plans, prepare bids for supplies, and select supervisory personnel. Bait materials for use on national forests were purchased from the emergency funds and shipped to the Bureau's bait-mixing station at Pocatello, Idaho, where the bait was prepared and sacked ready for shipment. Regular employees were either transferred to the emergency fund rolls as supervisors or cooperated closely with Forest Service officials in supervising the work. Laborers were chosen from the large central Civilian Conservation Corps camps and assigned to crew duty distributing baits.

A survey of rodent infestation on the national forests had been made during the fiscal year 1930 in cooperation with the Forest Service. Previously the Bureau had also conducted a survey of rodent infestation affecting timberlands on Indian reservations and other public lands. These two surveys indicate that range-destroying rodents, many of which directly affect reforestation, infest a total of 23,920,700 acres. In addition to this infestation, another survey has shown that porcupines are destructive to trees on 6,326,510 acres within national forests.

Rodent control has a definite place in reforestation programs, as pocket gophers, ground squirrels, porcupines, rabbits, and other rodents are in many places destructive to young trees and seedlings, particularly on areas that have been planted. Their working of the surface soil, destruction of ground cover, and burrowing through earthen check dams and drainage ditches are frequently the beginnings of wasteful soil erosion.

For example, rabbits on some plantations in the Superior National Forest in Minnesota are reported by Forest Service officials to have seriously damaged 94 percent of the white pine, of which 64 percent is recent; 85 percent of the Norway pine, of which 59 percent is recent; and 86 percent of the spruce, of which 57 percent is recent. In Wisconsin also plantations were heavily damaged by rabbits.

Close observation of areas in Arizona treated for porcupines during 1931 and 1932 shows that future operations there can be confined solely to patrol work to prevent reinfestation. In Oregon, on the Rogue River National Forest, porcupine infestation has decreased to such an extent as a result of previous control operations that practically no new damage occurred during the past year. Small areas were re-treated during the fall of 1932, and no new work was found necessary in the spring of 1933.

An example of the serious menace of porcupines to forestation is furnished on the Custer National Forest in Montana, where an examination of a stand of natural lodgepole pine at the head of Crooked Creek revealed that at least 30 percent of the timber had been attacked. On areas of the Coconino National Forest in Arizona porcupines have damaged as much as 70 percent of the seedlings and saplings. In many areas where reproduction is difficult, effective stocking is prevented when porcupines each year kill a large percentage of the seedlings.

On the Nebraska National Forest, in western Nebraska, where a large area of open land is being forested, it is impossible to grow the trees without first removing pocket gophers. In mountain areas of the West these rodents are especially destructive as the causative agents of erosion. To aid both the emergency work

in pocket-gopher control on forest and Indian lands and the regular cooperative work elsewhere, a farmers' bulletin (No. 1709) on the subject was completed during the year and submitted for publication.

Rodent control accomplished under the emergency conservation program before the end of the fiscal year was remarkable, considering the speed with which the project had to be established and the difficulties that were encountered. By June 30 a total of 1,433 Civilian Conservation Corps recruits and 136 trained foremen were working under the supervision of Survey leaders on national forests; 468,500 pounds of prepared bait had been treated at the Pocatello mixing station; and, in addition, 50,000 pounds of oats were steamed and crushed for prebait. Plans were made for the purchase about July 1 of supplies and the employment of Civilian Conservation Corps workers to treat 1,685,000 rodent-infested acres on Indian reservations, and for Bureau leaders to supervise the activities of 323 workers and 50 foremen, and in addition for the Survey to supply mixed bait from the mixing station at Pocatello, Idaho.

LAND ACQUISITIONS FOR WILD-LIFE REFUGES

MIGRATORY BIRD CONSERVATION ACT REFUGES

The refuge land acquisition program of the Biological Survey was laid before the Migratory Bird Conservation Commission at two meetings held during the year, one on December 8, the second on May 23. The first was held to consider recommendations for land acquisitions for which contracts had been negotiated during the preceding 5 months. All were covered by leases with options to buy, with the exception of one 160-acre tract on the Long Lake Refuge, in North Dakota.

Recourse to the policy of leasing lands was necessary because the funds with which to make purchases were curtailed and it was hoped that for the ensuing fiscal year appropriations to be made under the Migratory Bird Conservation Act would be sufficiently large to exercise the purchase options. This hope, however, was not realized: sufficient funds were made available to complete only the preliminary work, including boundary surveys, title examinations, and mapping of tracts that had heretofore been approved for purchase.

During the year cadastral surveys were made of 287 miles of boundary and subsidiary lines on refuges being acquired under the provisions of the Migratory Bird Conservation Act, and 256 miles on the Upper Mississippi River Wild Life and Fish Refuge. The boundaries of the lands so surveyed were permanently monumented and posted.

Only $318,000 of the $1,000,000 authorized by the Migratory Bird Conservation Act was appropriated for the fiscal year 1933, and this included $200,000 authorized for obligation during the fiscal year 1932. Furthermore, expenditures of funds appropriated were restricted by administrative limitations growing out of the depression. The total appropriations authorized to date in the 10-year program under this act is $1,875,000. Of this amount only $993,000 has been made available.

The entire program placed before the Migratory Bird Conservation Commission at the December 8 meeting contemplated the acquisition of 10,102 acres, distributed among the Crescent Lake Refuge, in Nebraska; Long Lake Refuge, in North Dakota; Bamforth and Hutton Lakes Refuges, in Wyoming; and the Sacramento Refuge, constituting a part of the famous Spalding ranch in the Sacramento Valley, in California. The second meeting of the Commission, held on May 23, was for suggesting to the new Administration the possibility of stimulating migratory wild-fowl refuge acquisitions under the Emergency Conservation Act of March 31, 1933, but on June 30 sanction had not been given to proceed as recommended.

The Migratory Bird Conservation Act anticipates the establishment of a nation-wide system of refuges, so that wild fowl may follow their natural flight lanes in the migration seasons with a fair chance of finding safe nesting, resting, and feeding places en route. The first year's appropriation under this act was required for examining numerous sites proposed as suitable for refuge purposes. This work is being continued, but with diminishing progress as the finances are reduced. At the close of the fiscal year, 3,710,927 acres of land in 141 units, distributed among the 48 States, had been methodically examined to designate land types, land cover, and values of land and cover; to determine the nature and extent of improvements that might be made; and to ascertain the extent of the individual ownership in each proposed unit. In addition, type maps have been prepared showing the physical conditions, the character of lands, and the soil cover. Some of the units have a great diversity of soil types, and each unit is made up of many

individual tracts under separate ownership. The economic values involved and the uses made of the lands of the different types produce a diversity of values for these individual tracts. Within the 141 units examined 6,756 landowners have title to 3,710,927 acres, an average of 48 owners per unit.

While the Biological Survey was able to take options on 10,102 acres for lease and for purchase during the fiscal year 1933, curtailed appropriations made it necessary to discard two tracts having an aggregate area of 10,790 acres. On the other hand, the Bureau has concentrated its efforts upon surveys, exact-acreage determination, and basic land-grant compilation, all of which are necessary in conveying title to the United States. Title was conveyed to 42,163 acres of land in 8 units in 7 States. In the matter of transfer of titles, this is the largest accomplishment for any 1 year since the work under the Migratory Bird Conservation Act began. In addition to lands purchased, the Biological Survey has taken advantage of every opportunity to utilize for migratory-bird sanctuaries lands in the public domain and lands previously withdrawn for other public uses. The progress thus far made under the provisions of this act is shown in table 1. Of the 137,664 acres thus far approved for purchase and lease-purchase, the average cost has been $4.57 per acre.

TABLE 1.—*Refuge areas acquired and approved for acquisition under the Migratory Bird Conservation Act program, to June 30, 1933*

State and county	Refuge	Areas approved by the Migratory Bird Conservation Commission for purchase and lease-purchase				Other areas acquired	Total
		Acquired by purchase	Pending title conveyance		Total		
			Under purchase agreement	Leased			
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Alaska	Semidi Islands					[1] 8,290	8,290
Arizona, Mohave	Boulder Canyon (see also Nevada).					[1] 312,687	312,687
California, Imperial	Salton Sea	8,982			8,982	[1] 36,578	45,560
Florida:							
Levy	Cedar Keys					[1] 224	224
Hernando	Chinsegut Hill					[2] 2,033	2,033
Jefferson, Taylor, and Wakulla.	St. Marks	19,313			19,313	[1] 16,298	35,611
Georgia, McIntosh	Wolf Island					[1] 538	538
Maine, Knox	Widows Island					[3] 12	12
Maryland, Dorchester	Blackwater	8,241			8,241		8,241
Montana, Cascade and Choteau.	Benton Lake					[1] 12,235	12,235
Nebraska, Garden	Crescent Lake	40,609			40,609	[1] 173	40,782
Nevada:							
Clark	Boulder Canyon (see also Arizona).					[1] 346,443	346,443
Churchill	Fallon		3,788	9,594	13,382	[1] 14,114	27,496
Nye	Railroad Valley					[1] 135,184	135,184
New Mexico, Chaves	Roswell					[1] 1,962	1,962
North Carolina, Hyde	Swanquarter	15,341	151		15,492		15,492
North Dakota, Burleigh and Kidder.	Long Lake	4,810	160	2,014	6,984	[1] [4] 1,810	8,794
Oklahoma, Alfalfa	Salt Plains					[1] 19,453	19,453
South Carolina, Charleston	Cape Romain	22,448			22,448	[1] [5] 31,613	54,061
Utah, Box Elder	Locomotive Springs					[1] 1,031	1,031
Washington, Grant	Lenore Lake					[1] 4,682	4,682
Wyoming:							
Albany	Bamforth Lake	965			965	[1] [4] 1,199	2,164
Do	Hutton Lake	1,248			1,248	[1] [4] 460	1,708
Total		121,957	4,099	11,608	137,664	947,019	1,084,683

[1] By Executive order or proclamation.
[2] By gift.
[3] By act of Congress.
[4] By lease without option to purchase; acquisition approved by the Commission.
[5] By cession.

The extensive Boulder Canyon Wild Life Refuge, in Nevada and Arizona, containing 659,130 acres, embraces the Boulder Canyon water power project, much of which is upland and desertlike. But this area has great value for sanctuary purposes for many forms of wild life other than migratory birds.

The Railroad Valley Migratory Bird Refuge, in central Nevada, containing 135,184 acres, is in the nature of a temporary withdrawal and will be made the subject of a more intensive study as soon as funds permit, to determine its ultimate refuge value through development of the water resources. The Lenore Lake Refuge, in Washington, containing 4,682 acres, and the Roswell Refuge, in New Mexico, containing approximately 1,962 acres, are also temporary withdrawals that will be studied further when opportunity offers. Upon satisfactory showing of refuge possibilities, temporary withdrawals will be made permanent. It is anticipated that out of public lands several additional refuge units will be reserved during the fiscal year 1934.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE

On the Upper Mississippi River Wild Life and Fish Refuge, which embraces extensive areas of bottom lands in Wisconsin, Minnesota, Iowa, and Illinois, there are 138,412 acres of land and water now under Federal jurisdiction, of which 77,947 were acquired by purchase, 545 by gift, 13,699 by Executive order, 5,731 acquired by accretion, and 2,745 held under option to buy. Intermingled with the lands so taken under jurisdiction are 18,054 acres of water in sloughs, ponds, and lakes. By reason of the fact that these are entirely surrounded by Government-owned lands, they form an integral part of the refuge and are under administrative control. In addition there are 19,691 acres of contiguous military-, State-, and city-owned and leased land that practically serve as refuge lands. This total does not, however, include the main channel of the Mississippi River passing through the lands, which is estimated to contain 70,000 acres. The Biological Survey has practically exhausted the possibilities of acquiring the remaining lands needed for refuge purposes by agreement with the owners of the tracts involved. To fulfill its responsibilities under the act creating this refuge and in order to round out the several units that go to make it up, the Survey has found it necessary to institute arbitrary proceedings in condemnation. During the year 1933 several such condemnation suits were instituted, and awards by the commissioners of view and by the courts hearing the cases supported the values that had been assigned to the lands by the Bureau. This process must be continued until privately owned lands intermingled with those that have been acquired by the Survey have been transferred to the United States. The lands being so taken are unoccupied and have no agricultural value. Their principal value at present lies in the fact that they are sought to be acquired by the Federal Government in its wild-life refuge program.

During the fiscal year 1933, title to 7,386 acres of additional lands have been vested in the United States through direct purchase and by arbitrary condemnation. The appropriations made available for the continuation of this work, which will involve the acquisition of 10,000 to 15,000 more acres of land, are seriously curtailed for the next fiscal year. For the past year, $34,033 was made available.

The act authorizing the acquisition of lands within this refuge authorized the appropriation of $1,500,000, but the total appropriations have amounted to only $870,033. The indications are that the acquisition of lands within the refuge can be completed for a sum materially less than authorized. To date the average cost of lands taken by purchase has been $6.65 per acre.

BEAR RIVER MIGRATORY BIRD REFUGE

Acquisitions on the Bear River (Utah) Migratory Bird Refuge have been reduced to lands that are to be taken by exchange. Two such acquisitions involve the exchange of 3,034 acres belonging to the United States for 7,733 acres of privately owned lands. Progress in the consummation of these has been exceedingly slow by reason of questions in reference to certain reliction rights.

The total acreage of lands within the refuge, including the exchanges referred to, will be 64,216 acres, consisting of 15,461 acquired by purchase, at an average cost of $1.68 per acre, 7,733 in the process of exchange, 2,773 ceded by the State, and 38,249 acres of public lands withdrawn. In addition easements aggregating 113 acres have been acquired for right of ways over privately owned lands.

CHEYENNE BOTTOMS MIGRATORY BIRD REFUGE ACT

Land acquisition under the Cheyenne Bottoms (Kans.) Migratory Bird Refuge Act of June 12, 1930, was progressing steadily toward consummation by the

process of condemnation proceedings, until terminated for lack of an appropriation. The 52 tracts within this proposed refuge could not be acquired by direct purchase, the majority of the landowners holding out for prices much in excess of the appraisals by the Biological Survey. In addition, titles have been more than ordinarily involved because of several speculative waves incident to oil booms, and now almost every acre in the Cheyenne Bottoms is covered by an oil lease. Drilling has taken place at a number of points there and in the immediate vicinity, so far without success, though oil has been developed in commercial quantities to the northwest and the southeast. Notwithstanding the difficulties, the Biological Survey proceeded with plans for the acquisitions, until in the stress of financial conditions Congress discontinued the appropriation begun in 1930.

WILD-LIFE REFUGE ADMINISTRATION

Wild-life refuges under the supervision of the Biological Survey now number 102, two new ones having been added during the year (p. 23). Most of them are in continental United States, but some are in Alaska, Hawaii, and Puerto Rico. Six were established primarily as big-game preserves (including a winter refuge for elk in Jackson Hole, Wyo.); one, Nunivak Island, Alaska, for experiments in the propagation and crossing of reindeer and caribou; and one in Alaska for muskrats and beavers. The others are for birds, and the 6 big-game preserves in the United States have been designated as bird refuges also.

BIG-GAME PRESERVES

Continuing the policy established some years ago of preventing overgrazing of the ranges, surplus big-game animals were removed from the four Biological Survey preserves where fenced herds are maintained. The numbers of big-game animals on these four preserves and the increase in certain species are given in table 2. The decrease from the previous year is due to the fact that a large number of surplus buffalo and elk were donated to needy Indians of several agencies for use as meat; and, to protect the grazing, more animals than usual were removed from Niobrara Game Preserve, Nebr., where facilities for disposing of them alive were available for the first time.

TABLE 2.—*Animals on fenced big-game preserves maintained by the Bureau of Biological Survey* [1]

Preserve	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total [2]	Young born in calendar year 1932 [3]		
					White-tailed	Mule		Buffalo	Antelope	Mountain sheep
National Bison Range, Mont.	544	[4] 96	-------	44	[4] 19	[4] 84	787	125	-------	15
Wind Cave Game Preserve, S.Dak.	235	[4] 41	[4] 54	-------	2	[4] 18	350	47	14	-------
Niobrara Game Preserve, Nebr.	126	58	12	-------	2	1	199	38	5	-------
Sullys Hill Game Preserve, N.Dak.	20	[4] 36	-------	-------	7	------	63	4	-------	-------
Total	925	[4] 231	[4] 66	44	[4] 30	[4] 103	1,399	214	19	15

[1] With the exception of young born, figures are for June 30, 1933.
[2] Including estimates.
[3] Young of elk and deer omitted; only estimates could be made.
[4] Estimated.

NATIONAL BISON RANGE

The herds of big-game animals on the National Bison Range, Mont., are in excellent condition this year, and unusually heavy rainfall has put the range in good shape. In line with the Bureau's policy of preventing overgrazing of the range, 89 buffalo, 86 elk, and 7 mule deer were removed from this preserve last fall and winter. Three of the buffalo were sold, and 30 of the elk were furnished for stocking an area in Mount Rainier National Park, Wash.; the remainder were killed on the range and donated for use as meat to Indians of the Blackfeet and Flathead Agencies.

Increases in the herds this season included 73 buffalo calves and 13 mountain sheep lambs, but 5 of the latter were destroyed by eagles. An object of much interest in the buffalo herd is an albino calf, born in May. So rare is an albino buffalo that this one has increased the number of visitors to the preserve.

Improvements on the range included a house for storage of fire equipment necessary for the headquarters buildings, and 15 wooden water tanks, which, in addition to 10 of concrete previously constructed, greatly aid in conserving the water supply for the animals in various parts of the range. An adequate supply of fresh water is necessary to reduce the possibility of any infection of the animals from stagnant, impure water.

WIND CAVE NATIONAL GAME PRESERVE

A rather severe winter was experienced at the Wind Cave National Game Preserve, S.Dak., but the buffalo, elk, antelope, and deer came through in excellent condition. Coyotes drifted onto this preserve in considerable numbers last fall, and a trapper of the Survey established headquarters there early in November. During the ensuing 6 months he took 39 coyotes and 3 bobcats. Various improvements and repairs have been completed, including road improvements and the installation of a steam-heating plant at headquarters.

Forty-three buffalo calves were born at this preserve this season, and 2 young buffalo were disposed of for exhibition purposes last fall. In the summer of 1932, 30 nesting species of insectivorous birds were identified on this preserve. Seven species are resident, and others spend the greater part of the year in the hills.

ELK REFUGE

The hay crop harvested at the Elk Refuge, in Jackson Hole, Wyo., in the summer of 1932, totaled 1,290 tons; 46 tons of this were destroyed by fire caused by lightning. Forty acres of oats grown and harvested on the refuge yielded 1,800 bushels of threshed grain and furnished a considerable quantity of straw for feeding to the elk.

The elk began to arrive at the refuge early in October, and by the time the hunting season closed on November 15 there were approximately 4,000 gathered on the refuge and on the nearby foothills. By the first of the year snow began to accumulate, and the elk were fed from January 6 until April 16. During this period approximately 2,200 tons of hay and 100 tons of cottonseed cake were consumed. About 250 tons of hay remain on hand for next winter, and the State game department also has left 116 tons of hay and 75 tons of cottonseed cake. But some concern is felt from the fact that at the close of the fiscal year the hay and grain crops were less promising than last year, and the State and Federal funds available for purchase of hay had been reduced.

In March a count of the elk on all the feeding grounds, made in cooperation with the State game department and the Forest Service, revealed a total of 11,239 on the 3 refuge feeding grounds and on the 3 maintained by the State. This exceeded by about 1,250 the number of elk fed on these areas in any previous winter. In addition, the State game department fed approximately 300 elk on a ranch about 35 miles to the north. The greater number of the elk came through the winter in fairly good condition; the losses were estimated at slightly over 600 animals. As a large number did not follow their old habit of migrating from the refuge toward their summer range with the disappearance of snow, it was necessary to make three drives to force the animals to leave the refuge and adjoining ranches, and it was not until the first week in June that they finally disappeared for the summer season.

Improvements at the refuge included the construction of 2 bridges, 1 across Flat Creek near headquarters, the other across a large spring; and the erection of 1½ miles of new fence.

NIOBRARA GAME PRESERVE

Twenty-four buffalo calves were born at the Niobrara Game Preserve, Nebr., during the fiscal year, and all survived in strong and healthy condition. In the summer of 1932 temporary fences were constructed across the Niobrara River to connect the north pasture with an enclosed new pasture on the south side of the river where corrals had been constructed. This improvement made it possible to move the animals across and for the first time to capture buffalo and elk alive for disposal. In all previous disposals of the surplus animals at this place, it was necessary to butcher them for use as meat. Of the 41 buffalo and 45 elk removed from this area during the season, 13 buffalo and 30 elk were furnished to parks and State game preserves for exhibition and propagation and 3 elk were sold for propagation. The other animals were disposed of for use as meat. Of these, 21 buffalo and 3 elk were donated to the Indians of the Rosebud Agency, S.Dak.

Late in November the buffalo were rounded up and driven across the river to the new south pasture because of shortage of winter forage in the old pasture, but

the action proved disastrous, as on January 2, 26 buffalo were drowned by breaking through the ice when attempting to recross the Niobrara River. Accustomed to crossing over ice in creek bottoms in their old pasture, the animals apparently had no fear of the ice on the river. While in some places the ice was sufficiently thick to support them, unfortunately they selected a crossing place where it was thin and near an open channel. Nine were salvaged and pronounced fit for food by a veterinarian of the Bureau of Animal Industry and were included in the number donated to the Indians of the Rosebud Agency.

In addition to the buffalo and the elk, which also were driven from the old pasture into the corrals last fall, there are 12 antelope and 3 deer on the preserve.

Approximately 1,200 tons of surplus hay were harvested under permit in the area outside the big-game pastures by nearby ranchers, who were in need of the feed for their stock.

SULLYS HILL NATIONAL GAME PRESERVE

The big-game animals are in good condition on the Sullys Hill National Game Preserve, N.Dak., and the herds were increased by the birth of 3 buffalo calves and about 8 elk calves. One buffalo and 2 elk, surplus in the herds, were disposed of as meat. The last antelope on the preserve died in June, and it is apparent that the area is not suitable for the maintenance of these animals.

CHARLES SHELDON WILD LIFE REFUGE

Drought conditions that prevailed over the Charles Sheldon Wild Life Refuge and the surrounding area in Nevada at the close of the fiscal year are adversely affecting all forms of the wild life. While there was no marked increase in the numbers of antelope during the past year, the drought situation will probably increase the number using the refuge until the first heavy snowfall starts their seasonal migration. Peak numbers during the October-November concentration were estimated at between 1,500 and 2,000, with approximately 1,000 within the borders of the refuge at the close of the year. Although extremely cold weather prevailed over the winter ranges in December and January, the forage was not snow covered, and the antelope wintered without abnormal winter kill. They returned to the refuge in good condition, and the 1933 fawn crop was excellent. The mule deer also wintered well and are increasing rapidly on the refuge. After a decided decrease in the number of sage grouse there in 1931 and 1932, a slight increase was apparent this season, with the hens rearing larger broods.

BIRD REFUGES

NEW REFUGES ESTABLISHED

Two new wild-life refuges, chiefly for the protection of migratory birds, were placed under the jurisdiction of the Bureau of Biological Survey during the year. These were the Boulder Canyon Wild Life Refuge, in Arizona and Nevada, covering about 620,000 acres, approximately 132,000 of which will be the vast artificial lake created by the Boulder Dam on the Colorado River; and the Widows Island Migratory Bird Refuge of 12 acres, in Maine, formerly a naval reservation and transferred to the Department of Agriculture by the Navy Department under act of Congress approved December 22, 1932.

BIG LAKE BIRD REFUGE

In November 1932 it was estimated that approximately 30,000 ducks and coots were on the Big Lake Bird Refuge, Ark. High water from January to March made the waterfowl feeding grounds unsatisfactory, but hundreds of ducks stopped at the refuge in the spring and stayed until May. There is a good showing of wood ducks and hooded mergansers on the refuge, and these species have nested and raised broods of young. To help maintain the lake level at periods of low water, a dam was constructed last summer in one of the outlets of the main body in the southwestern part of the refuge.

LAKE MALHEUR BIRD REFUGE

The fall migration of ducks at the Lake Malheur Bird Refuge, Oreg., showed a heavy increase over 1931 but a decided decrease from years of high water. Nesting conditions for the Canada geese were better than usual in this locality and resulted in a good hatch of young, though much under the average for high-water years. Banding operations were carried on at the refuge, and a few ducks and geese were fed there during the winter.

The question of water rights in the flow of the Blitzen River is still pending in State court, the settlement of which is of vital importance to the maintenance of an adequate water supply for birds at Lake Malheur. This river is the principal source of supply for this important refuge.

UPPER KLAMATH WILD LIFE REFUGE

In December approximately 3,000 ruddy ducks, a few of other varieties, and about 500 horned and eared grebes were ice-bound in the lake at the Upper Klamath Wild Life Refuge, Oreg. The protector of the refuge, with about 25 volunteer helpers, spent 2 days in rescue work, and as a result saved about 1,200 of the ducks and 100 of the horned and eared grebes, and transported them to recovery pens at the refuge headquarters. Dead birds taken from the ice and still useful for food were turned over to charitable organizations.

BLACKWATER MIGRATORY BIRD REFUGE

Experimental work was performed in connection with the introduction of new duck-food plants on the Blackwater Migratory Bird Refuge, Md., and a study was made of the waterfowl. A census of the muskrats was taken, and other data relating to these animals were recorded. As a result of cooperation with owners of adjoining marsh land in burning out the boundary lines, few fires reached the refuge and only a small area was burned over.

Improvement work during the year included repairs to the headquarters house, erection of a fence to prevent livestock damage, and construction of a small wharf, garage, and tool shed.

Recent State legislation forbidding hunting within 100 yards of the refuge boundary will afford the area much additional protection.

CAPE ROMAIN MIGRATORY BIRD REFUGE

Thousands of ducks concentrated on and in the vicinity of the Cape Romain Migratory Bird Refuge, S.C., in December, and by January it was estimated that there were from 20,000 to 40,000 ducks in the district, mostly mallards, with black ducks, scaups, pintails, and many teal. A wild-life survey of the refuge revealed 42 species of birds. The number of breeding pelicans was double that of last year. After the spring storm tides had swept over the nesting grounds, destroying nests and eggs, the pelicans built again, but high tides early in June again destroyed the nests, and the birds finally deserted the area, though a few remained on a part of the refuge. The royal tern colony this year numbered about 12,000 birds, and last summer about 1,200 of these birds were banded on the refuge. A great many least terns were nesting on the area this year. Each year, from May until the middle of August, on high tides at night great sea turtles crawl out on the beaches of the refuge and lay their eggs. The number of turtle nests, on the part of the refuge frequented, was estimated at from 500 to 700, with a total of more than 75,000 eggs. From 15 to 20 percent are said to be destroyed by sand crabs.

CRESCENT LAKE MIGRATORY BIRD REFUGE

Almost a 100 percent increase was observed in the number of birds on the Crescent Lake Migratory Bird Refuge, Nebr., over last year, and on June 30 it was estimated that the number of young waterfowl would be 80 to 100 percent greater than in 1932. Blue-winged teal were the principal nesting birds among the ducks, with smaller numbers of pintails, mallards, gadwalls, and ruddy, redhead, shoveler, and baldpate ducks. Some canvasbacks that remained on the refuge during the summer did not appear to be nesting. Long-billed curlews have shown a decided increase over last year.

Spring rains brought water levels in the lakes within the refuge to a point higher than in 1932, but subsequent lack of rain has lowered them rapidly. Muskrats have been increasing in numbers since the lakes now in the refuge have been closed to general trapping. Five lakes were opened to trapping under permit during the spring, and 484 muskrats were taken by the permittees.

During the year an important purchase was completed of a 2,000-acre tract that joins the two divisions of the refuge. Recreational areas were set aside on Crane, Island, and Hackberry Lakes, which are among the most popular fishing resorts in western Nebraska. The designation of the fishing and other recreational areas has been favorably accepted by the people of the locality. Some 800 trees were planted at the Island Lake recreational area last spring, through the cooperation of the Oshkosh (Nebr.) Chamber of Commerce and the Boy Scouts;

about 800 additional trees were planted around headquarters; a fence was erected to keep cattle from a camp ground; and a combination garage, workshop, and coal shed was built.

ST. MARKS MIGRATORY BIRD REFUGE

The most notable bird wintering on the St. Marks Migratory Bird Refuge, Fla., is the Canada goose, and during the winter of 1932–33 it is estimated that about 3,000 were present. The birds next in abundance were scaups, though black ducks were fairly numerous and canvasbacks were there in considerable numbers. Other species of ducks are found on this area, as well as shore birds, gulls, bobwhites, doves, turkeys, and a few birds of prey. Deer are somewhat plentiful, and last fall were abundant. Among the improvements completed on the refuge may be mentioned the headquarters house, a barn, fences, and a wharf. A boat was acquired for patrol purposes.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE

Areas closed to hunting and trapping during the year on the Upper Mississippi River Wild Life and Fish Refuge were approximately the same as last year. Some additions were made where acquisitions made it possible to straighten and make use of natural boundaries, such as waterways, agricultural lands, and fence lines.

Development of the 9-foot channel on the upper Mississippi River is progressing, and two locks are now under construction, one at Alma, Wis., the other near Whitman Station, Minn., and the indications are that the work will be so expedited on other dams that the entire project will be completed in less than 5 years. One effect of the Alma Dam will be to stabilize the water level on several thousand acres, and thus materially to increase the value of the refuge to waterfowl and muskrats. Most of the land behind the Whitman Dam is owned by the Winona Park board, and there is no prospect of its affecting much of the refuge.

During the year crews of surveyors identified practically all refuge land along the west shore of the Mississippi from Lansing, Iowa, north to La Crescent, Minn., and a considerable area in La Crosse County, Wis. All lands surveyed were appropriately posted, and many of the boundaries were cleared of timber and brush to aid in their better identification and to provide firebreaks. As a result, it will be possible to maintain additional closed areas during the year 1933. A large part of the refuge is yet to be surveyed and posted.

Though a very low stage of water prevailed throughout the refuge during 1931 a new low record was established in 1932, many lakes, sloughs, and ponds being too dry during the summer to produce a satisfactory crop of aquatic vegetation as food for waterfowl and fur animals.

Migratory wild fowl were present in about normal numbers. Though there seemed to be an unusually large fall migration of Canada geese, some observers believe that this was merely a concentrated migration over a shorter period than usual. The lower section of the refuge in the vicinity of Bellevue, Iowa, and Savanna, Ill., continued to attract the largest numbers of birds. The concentrations here will be made the subject of more intensive study, since reports prior to last year listed this section as being relatively unattractive. Favorable water stages during the spring migration led many observers to believe that there was a large increase in the number of migrants. The water and food conditions prevailing in the spring of 1933 probably induced the birds to remain for a longer period than usual, and large numbers of pintails and mallards were present.

The only public trapping of fur-bearing animals permitted on the refuge was for minks, from November 15 to March 1, during which 101 trappers reported a take of 202. This limited catch indicates that minks are not overabundant on the refuge. So marked was the scarcity of muskrats, due in part to low water, that it was necessary to refrain from taking even scientific specimens, though these are needed for study in connection with the wild-life management program.

Eighteen fires occurred on the refuge during the year and burned 2,650 acres, a considerable increase over the previous year, both in the number of fires and in the acreage involved, although efficiency in the system of detecting and reporting fires had been increased. A majority of the fires occurred late in the season, beginning in November and lasting into January. In some respects this added materially to the difficulties of control, as roads were in some cases impassable; frozen lakes, streams, and sloughs made it difficult to obtain a supply of water; and the extreme cold weather prevented effective use of pumps. Fair stages of water assisted materially in preventing fires during the autumn of 1932, but with the falling of the river as the season advanced, fires became more prevalent. The small number from February to the end of June is attributable to the fact that there was then a fair stage of water.

Approximately 2,500 trees and 1,000 shrubs were planted this year, under favorable planting conditions, and the survival of new stock has been satisfactory. A recheck of former plantations disclosed that a high percentage of trees survived and have made splendid growth.

Winter feeding of upland birds as well as waterfowl has continued on the refuge. While as much feeding as possible was carried on, the operations were for the most part limited to the immediate vicinity of ranger stations. Waterfowl were fed at strategic points both during the fall and spring migrations. One result of the winter feeding on the refuge was to stimulate similar work by individuals elsewhere, to the great advantage of wild life.

Special-use permits were issued as formerly, and, in addition, through authorization from the Secretary of Agriculture, approximately 200 free-use permits for removal of dead, down, and defective timber were issued to persons unable to purchase fuel. Likewise, by order of the Secretary, deserving persons have been issued free permits authorizing them to use small parcels of suitable land within the refuge for gardens. Each permittee is required to sow some small grain or set out other food-producing plants, to be left unharvested as a source of winter food for wild life.

BEAR RIVER MIGRATORY BIRD REFUGE

On September 26, 1932, the Bear River (Utah) Migratory Bird Refuge was formally established by Presidential proclamation, and regulations for its administration, effective October 1, were issued by the Acting Secretary of Agriculture. The superintendent's headquarters were moved from Ogden to Brigham, Utah. This change has permitted much closer supervision of the refuge and has proved highly satisfactory.

That the refuge is attractive to waterfowl is evidenced by the great concentration there of wild ducks, geese, shore birds, and nongame birds during the past year. This condition is not in any sense an indication of a general increase in waterfowl, but shows that the refuge is attractive to the birds.

The dikes, river-control works, and spillboxes have proved to be satisfactory, and there is no indication that they will not continue to function as planned. The refuge boundaries have been fully posted.

All units produced a good supply of submerged varieties of duck food, and sago pond weed and other food plants continued to show a marked increase. The food supply on Bear River Refuge is sufficient to take care of many more birds than have thus far utilized it.

A serious outbreak of western duck sickness resulted in heavy mortality from August 10 to about November 10. Though most serious outside the refuge, the outbreak also caused a great loss within the boundaries. During the concentration of ducks on their northern flight in the spring of 1933, another outbreak of this sickness occurred, in a mild form, however; there was virtually no mortality. This outbreak cleared up entirely, and at the end of the fiscal year there was no evidence of a recurrence.

Studies made by the Biological Survey have proved definitely that the so-called "duck sickness" is caused by a toxin developed by bacterial activity in some form of organic decay, as discussed in last year's report. It is quite possible that a condition of alkalinity assists the development of the bacteria (*Clostridium botulinum*, type C). The malady, however, is caused not by the bacteria but by the poisons deposited by them. When conditions are such that wild fowl have access to the poison and swallow it with their food, duck sickness results. With the limited present knowledge, no effective remedy has been found other than to flood affected areas with fresh water, and this was one of the objects sought by the establishment of the Bear River Refuge. Past experience in the handling of smaller units of land in the same section by private gun clubs indicates that, though outbreaks of duck sickness may occur for some years following the flooding of an area once dry, these outbreaks will gradually decrease in violence as the poison is washed away and gradually dissipated. Though there may be future outbreaks of duck sickness within the units of the refuge, it is anticipated that these will diminish and eventually cease as the result of continued flooding operations. Unfortunately, however, there is at the present time no way by which this method can be used to prevent duck sickness in the extensive areas outside the refuge, and serious losses from this source must be anticipated unless further study develops some other remedy that will be applicable and efficacious.

In cooperation with the State game commissioner and after consultation with a committee representing the sportsmen of Utah, an open area for public shooting was agreed upon. By order of the Secretary of Agriculture, 13,000 acres representing about 40 percent of the flooded part, were designated as a public shooting ground.

Permanent improvements on the refuge included provision of a headquarters cottage, two guard cabins, a garage and boathouse, and water and gas systems.

REFUGES IMPROVED UNDER EMERGENCY CONSERVATION PROGRAM

On May 29, the President approved the establishment of Civilian Conservation Corps camps at the Blackwater Migratory Bird Refuge, Md., the Swanquarter Migratory Bird Refuge, N.C., and the St. Marks Migratory Bird Refuge, Fla. These refuges were acquired by the Department under the Migratory Bird Conservation Act of 1929 and have been under jurisdiction of the Biological Survey for about 2 years. With the aid of the Conservation Corps, extensive developments at each refuge will include construction of roads, trails, fire lines, and lookout towers, and dams to create fresh-water ponds for wild-fowl food production. These improvements will greatly facilitate the administration of the several areas and materially improve their value in wild-life conservation.

SUPPLEMENTARY REFUGES

The appeal made by the Biological Survey in the spring of 1932 urging that individuals and organizations establish numerous small sanctuaries for migratory birds has met with some response, but not in the measure wished for. There are still many opportunities for attracting waterfowl to sloughs, ponds, and lakes that have great possibilities as areas for wild life but are not of sufficient size to justify administration by the Government. Renewed interest in this effort to supplement the Federal refuges is greatly desired.

An example of what might be done elsewhere is demonstrated in North Dakota, where, through interest in this program, several Civilian Conservation Corps camps have been detailed on water-conservation work, principally the construction of relatively inexpensive dams in stream beds that periodically go dry. Such developments not only improve the ground-water conditions, but also provide for fishing and serve as resting and feeding areas for migratory birds.

ADMINISTRATION OF LAWS FOR WILD-LIFE CONSERVATION

Statutes administered by the Bureau of Biological Survey for the protection of wild life are the Migratory Bird Treaty Act of 1918, protecting birds that migrate between the United States and Canada; the Lacey Act of 1900, pertaining to interstate shipments and importations of wild birds and mammals; laws affecting animal life and property on Federal wild-life refuges; the Migratory Bird Conservation Act of 1929, authorizing establishment and administration of bird refuges; and the Alaska game law of 1925, through the Alaska Game Commission.

UNITED STATES GAME PROTECTORS

At the end of the fiscal year there were 25 United States game protectors in the permanent field force engaged in the administration of the Migratory Bird Treaty Act and the Lacey Act. In view of the efforts being made to reduce the expense of government, it will be necessary during the ensuing fiscal year to reduce this small force still further, and to abandon several enforcement districts until such time as the financial condition of the Government permits resumption of this important work.

The essential importance of regulations to reduce and control the annual kill of ducks has been greatly emphasized during the past few years, during which time the wild fowl have suffered serious losses both from overshooting and from the effects of disastrous and long-continued drought on their principal breeding ranges. At this time, when it is of the utmost importance that a sufficient breeding stock of birds be preserved, it is imperative that the force of United States game protectors be increased sufficiently to obtain reasonable and adequate enforcement of these emergency conservation measures.

The Federal game protectors are not only law-enforcement officers—they are also constantly assisting game conservation in an educational way. In this they were aided by publications of the Department issued during the year (Miscellaneous Publication No. 151 and Service and Regulatory Announcement B.S. 77) on Federal and State game laws (including a poster (no. 51-Bi) on open seasons for game birds), and information issued by the Biological Survey through the press and by radio. In the 1933 Yearbook of Agriculture was published a table (493, p. 753) on hunters' licenses issued by States, with total money returns, for the seasons 1930 and 1931, reprinted separately for correspondence purposes.

MEASURES TO PRESERVE WATERFOWL

At the beginning of the breeding season, water conditions on the most important areas in the northwestern United States and the southwestern Canadian Provinces showed some improvement, and the extensive investigations the Bureau had conducted throughout the year indicated that the reduction of the shooting season in the United States from 3 and 3½ months to 1 month in 1931, and to 2 months in 1932, had been effective in conserving the supply of mature birds during their stay in the United States.

Other amendments made in 1932 placed a continuous closed season on ruddy and bufflehead ducks, reduced the bag limit on mourning doves from 25 to 18 a day, forbade mourning-dove hunting within 100 yards of a baited area, and restricted to 25 the number of live-duck decoys that might legally be used. In the total daily bag of 15 for all ducks the number for certain species was restricted to 10, except for eider ducks, on which the limit was set at 5, in view of the fact that most of these species had not recovered from the effects of the drought that had prevailed on their breeding grounds for several years, and the numbers of others had been materially reduced by the effects of heavy shooting and loss of marsh lands by drainage and other causes.

A fairly satisfactory return migration of mature birds moved northward to the breeding grounds in the spring of 1933. Early reports from Survey investigators in these areas were encouraging with respect to water conditions, and there was some reason to hope that there would be a gradual return to normal in these vast regions, which produce more than half the ducks that migrate to the United States every year. Early in June, however, the observers began to note a general cessation of rainfall throughout the entire zone, and within a few weeks it became apparent that the water conditions were again to be disastrously below normal, with the usual serious consequences to waterfowl. In view of this situation it is obvious that means must be adopted to effect further reductions in the numbers of birds to be taken by the gunners in the United States during the coming season.[1]

Of benefit to the waterfowl that frequent the District of Columbia was an act of Congress of July 14, 1932, which, supplementing existing laws, converted the whole area into a wild-life sanctuary by making it unlawful to hunt or needlessly disturb wild ducks and other waterfowl on any of the waters of the District.

The advisory board, Migratory Bird Treaty Act, was reorganized during the year, with a membership of 23. For the first time in the history of the board, which was established for the purpose of advising the Secretary on matters connected with the adoption of wild-fowl hunting regulations, a woman was appointed to membership—Mrs. William L. Wilson, chairman of the division of conservation of natural resources of the General Federation of Women's Clubs. The first meeting of the new board was planned for early in July, to consider the wild-fowl situation and to discuss measures that might be the most efficacious in the present emergency.

In connection with restrictions that have been or may be placed upon the gunners in the shooting of waterfowl, it is desirable to restate a fundamental principle of game conservation—that the waterfowl-refuge system is wholly inadequate alone to preserve a sufficient breeding stock during an emergency of a nature similar to that which has prevailed during the past few years. The sole effective means by which a sufficient supply can be saved is greatly to reduce the total number of birds annually killed by gunners during the open season. This result can be attained only by restrictive regulations, adequately enforced, generally observed, and respected by the gunners themselves.

LAW VIOLATIONS AND PENALTIES

MIGRATORY BIRD TREATY ACT CASES

The number of cases of violations of the Migratory Bird Treaty Act reported by the Department for prosecution was slightly less than during the preceding year. The number of convictions obtained also showed a slight decrease, but there was an increase in the fines imposed. Disposition of the cases is shown in table 3. Action was not recommended in 105 cases, on account of lack of evidence, youthfulness of the accused, or other satisfactory reasons. Fines and costs ranging from $1 to $1,800 and aggregating $8,329.53 were imposed by the Federal courts. Jail sentences were imposed as follows: 1 to 20 days, 6; 30 days, 8; 60

[1] Amended regulations approved by the President on Sept. 11, 1933, although retaining the 2-month seasons on waterfowl, reduced the daily bag limits from 15 to 12 (on certain ducks from 10 to 8) and closed the season on brant in the Atlantic Coast States.

days, 1; 90 days, 2; and 18 months, 1. Sentences were suspended in 4 cases for 5 years each, and in 9 other cases for 30, 60, 90, or 180 days, and in 45 cases the offenders were placed on probation for periods ranging from 6 months to 5 years. Three cases tried before a jury resulted in verdicts of guilty. Seizures of migratory game birds had an estimated value of $1,000. Such birds as could be utilized for food were donated to hospitals and other public charitable institutions.

TABLE 3.—*Cases of violation of the Migratory Bird Treaty Act disposed of during the fiscal year and cases still pending June 30, 1933*

Cases disposed of	Number	Cases pending	Number
Convictions	279	Pending from former year	366
Dismissals	35	New cases	352
Verdicts of not guilty	11		
No bills found	5	Total	718
Nol-prossed	25	Disposed of	374
Death of accused	1		
Denied leave to file	3	Pending at end of year	344
Closed without prosecution	15		
Total	374		

Outstanding cases during the year were as follows: For killing swans, 3 violators in Maryland were given suspended jail sentences of 6 months and suspended fines of $500 each, and were placed on probation for 1 year. One case in Kentucky, involving the sale of wild ducks, was terminated by a fine of $100 and a 2-month jail sentence. One case of hunting geese with an airplane in Illinois was disposed of by a $5 fine. One case in Tennessee, involving the illegal interstate transportation of live quail, resulted in a fine of $1,800 and a jail sentence of 18 months, to stand suspended on payment of the fine; this defendant, fighting removal from Texas to Tennessee for trial, sought release on a writ of habeas corpus, and when this was denied he appealed to the United States Circuit Court of Appeals for the Fifth Circuit, which sustained the action of the lower court in remanding him to custody of the marshal; a petition to the United States Supreme Court for a writ of certiorari was then denied.

Other cases that may be mentioned of violation of the Migratory Bird Treaty Act, successfully terminated during the year included trapping ducks, 2 (Virginia); hunting ducks on the first day of the open season prior to noon, 4 (3 in California and 1 in Texas); killing ducks in excess of the daily bag limit, 8 (6 in California and 2 in Louisiana); killing ruddy ducks, 1 (California); shooting over more than 25 live-duck decoys, 4 (2 each in Missouri and Louisiana); and killing doves over baited fields, 15 (Georgia).

UPPER MISSISSIPPI RIVER REFUGE CASES

Thirteen new cases involving violations of the Upper Mississippi River Wild Life and Fish Refuge Act were submitted for prosecution during the year. Of these 9 are pending; 3 were disposed of by fines totaling $50, and 1 by a 30-day jail sentence. In addition, 4 cases previously reported were terminated, 2 by fines of $10 each; 1 by a suspended jail sentence of 90 days, the defendant being placed on probation for 3 years; and in 1, the defendant, upon plea of guilty, was placed on 18 months' probation.

Thirty-one persons apprehended on the refuge by reservation rangers for violating State game and fish laws were proceeded against in State court, where 3 were dismissed, 12 received jail sentences of 3 to 60 days, 2 were paroled for 1 year, 6 received suspended sentences on payment of costs, and 8 paid fines and costs totaling $482.

INTERSTATE SHIPMENTS OF WILD BIRDS AND MAMMALS

In extensive investigations under the Lacey Act, which seeks to lessen interstate shipments of wild birds and mammals made in violation of State law, United States game protectors discovered a number of infractions of State game laws with reference to traffic in pelts of fur-bearing animals. Evidence of apparent illegal shipments of game animals also was developed through these investigations.

As a result of inspections made at raw-fur receiving centers, information regarding 4,300 shipments that apparently contained skins illegally taken or shipped was transmitted to the State game departments. The several States closed during the year 150 cases based on information originally furnished by the Survey, in

which the aggregate of fines and costs was $11,591. In 578 other investigations by the States on information furnished by the Survey, it was found that the shipments were lawfully made or that for certain reasons State prosecution was undesirable.

Evidence in connection with 421 violations of State game laws, involving all classes of offenses other than interstate shipments of skins of fur animals, was furnished to the game departments of 31 States. As a result of prosecutions of these offenders in State courts fines and costs aggregating $11,764.65 were imposed.

PERMITS ISSUED UNDER MIGRATORY BIRD TREATY ACT

The regulations under the Migratory Bird Treaty Act provide for the issuance of permits to take, possess, buy, sell, exchange, and transport migratory waterfowl for propagation; and to take, possess, buy, sell, exchange, and transport migratory game and nongame birds for scientific purposes. The number of such permits outstanding at the close of the year, including permits issued during the year, was as follows: Scientific collecting, 2,305; scientific possession, including taxidermist, 548; special scientific possession, 1,394; bird banding, 1,671; and propagating (possession and sale), 4,560.

Ninety-five permits to take migratory waterfowl for propagation also were issued. Reports submitted by permit holders covering operations thereunder during the calendar year 1932 show 63,951 wild ducks raised in captivity, of which 61,197 were mallards and 1,947 black ducks, and the others mainly wood ducks, pintails, teals, gadwalls, canvasbacks, bluebills, shovelers, baldpates, and redheads. The number of wild geese raised was 4,381. Migratory birds propagated and reported sold during the year included 7,868 ducks and 218 geese for food, and 7,391 ducks and 2,951 geese for propagation.

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FOREIGN IMPORTATIONS UNDER LACEY ACT

The close of the fiscal year marks the completion of 33 years of regulation of importation of species of foreign birds and mammals. During this time approximately 12,000,000 birds and many thousands of mammals have been brought in under some 20,500 permits. During all this time so far as known not a single injurious species has gained a foothold in continental United States.

Regulations issued by the Secretary of the Treasury and enforced by the Customs Service, governing the importation of foreign wild animals and birds into the United States under permits of the Secretary of Agriculture, were codified, amended, and published during the year. In order to insure more effective protection against the entry of injurious species some changes were made, including the requirement of a permit for each shipment of mammals, whether it contains one or several specimens. Heretofore not to exceed five mammals or birds might be brought in under a passenger's baggage declaration without a permit, and through this loophole doubtless some prohibited species gained entrance which otherwise would not have been admitted. The exemption of five now applies only to parrots and canaries accompanied by the owner. To guard against the introduction of the mongoose, the mynah, and other injurious species from Hawaii, permits are now required for the entry of each shipment from Honolulu to San Francisco, Los Angeles, or other Pacific-coast ports. Attention has been called to the fact that the immediate transportation provisions of the tariff act are subordinate to those of the Lacey Act, so that all species must be entered at the border before proceeding to destination under bond. Thus, birds consigned to Chicago, St. Louis, or other interior ports must be entered at New York, Philadelphia, or some coastal port without the privilege of being entered at destination. Provision has been made for increased inspection at Pacific-coast ports through cooperation with the Bureau of Plant Quarantine and the appointment of additional inspectors at Los Angeles and San Diego.

On account of the general depression the number of foreign birds imported was less than that of the previous year. This is particularly noticeable in the case of quail, in which the reduction was nearly 50 percent.

The number of importation permits issued during the year was 912, of which 32 were unused and canceled, a decrease of 238 from 1932. Shipments inspected decreased from 407 to 267. Nineteen additional permits were issued at Honolulu, Hawaii, for the entry of 147 miscellaneous birds. The total number of all foreign birds imported was 311,036. This was less than half the number brought in during 1930, the high-water mark of importations, when 825,736 were entered. Of the total number of birds brought in in 1933, 2,283 were entered without permit, many of them brought in under declaration of passengers' baggage. Included in the total were 261,633 canaries, 1,217 parrots, 22,110 Mexican quail, 6,021 Hungarian partridges, and 20,055 miscellaneous birds.

PROHIBITED SPECIES

No prohibited species were entered during the year, but on April 14 a report was received that a miscellaneous collection of mammals carried by an expedition returning from the Tropics to San Diego contained a mongoose. Upon receipt of the notice the captain of the vessel was advised that the animal could not be admitted even though castrated, and accordingly it was put ashore at Acapulco, Mexico.

BEARS

The importation of black-bear cubs from Canada continued with only a slight decrease from previous years. Permits were issued for the entry of 83 separate shipments containing a total of 174 cubs, as compared with 190 in 1932. Most of the bears were brought to New Jersey, a few to other States.

ANTHROPOID APES AND MONKEYS

The records of the year were marked by the entry of two gorillas, one of which came from West Africa in August, and the second, a young animal captured in Kribi, French Cameroons, was shipped from Freetown, Sierra Leone, in January. Considerable correspondence developed in regard to the latter gorilla, which lacked the credentials necessary for the issuance of an importation permit. The animal was allowed to land under bond, but formal entry was not completed until the necessary authorizations and consular certificate had been obtained, 3 months after arrival.

As usual, monkeys in considerable variety were brought in, rhesus monkeys alone numbering 2,686. The list comprised several interesting species including baboons, langur gibbons, colobus monkeys, and pig-tailed macaques from the Old World, and lion-headed and woolly monkeys, white-necked and white-faced marmosets, and Oersted's titi monkeys, from tropical America. Many of these animals are brought in as pets by passengers, and under the new customs regulations a permit was necessary in each case.

MEXICAN QUAIL

Judging by the permits issued to export quail from Mexico, extensive preparations were made by shippers last spring, but the depression in the United States and the restricted market for the birds greatly reduced the numbers actually brought in, the total being 22,110, as compared with 39,131 last year. The importations this year were the smallest in a decade; only 9,123 were imported in 1923. No evidence of quail disease was apparent, and the reduced entries were due entirely to economic conditions. No quail were entered at Brownsville, and the entries at Laredo and Eagle Pass were distributed mainly to four States: Kansas, 8,717; Tennessee, 6,000; Texas, 4,099; and Kentucky, 2,500. The other birds, numbering nearly 800, were distributed in small lots to 16 States—Arizona, Arkansas, California, Delaware, Florida, Georgia, Louisiana, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, and Washington.

The total number brought in since 1910 is approximately 714,000.

HUNGARIAN PARTRIDGES

Entries of Hungarian partridges for the year numbered 6,021, a decrease of 595 from last year. Widespread interest has developed in the introduction of these birds, but lack of funds for purchases by game commissions and associations and the difficulty of procuring stock in some European countries militated against large importations. During the 20 years in which the main importations have been made, somewhat less than 300,000 birds have been introduced, but in the meantime the species has become acclimated in several of the Western States, notably Wisconsin, South Dakota, and Washington.

CAGE BIRDS

Importations of canaries and other cage birds show a considerable decline, in spite of efforts to stimulate the trade during the holidays by sales at popular prices. The total number of canaries imported was 261,633.

Parrots and parrakeets show a decided decrease. Because of the recurrence of parrot fever in California and also at some points in the Eastern States, quarantine regulations were made more drastic, especially on the Pacific coast, and consequently comparatively few birds were imported. Under the revised regulations of the Public Health Service a certificate from the health authorities in the place of origin must accompany shipments of more than five birds, certifying as to the condition both of the birds and of the aviary or other distributing establishment from which shipped. A health certificate from State authorities is also required for interstate shipments of parrots.

RARE BIRDS

Among the rare birds imported during the year were 4 elegant parrakeets (*Neophema elegans*), an Australian species now in danger of extinction; 1 black cockatoo (*Probosciger aterrimus*), from Singapore; 6 black-footed penguins (*Spheniscus demersus*) from South Africa; 2 flightless cormorants (*Nannopterum harrisi*) and 4 Galapagos penguins (*Spheniscus mendiculus*) from the Galapagos Islands; 1 shoebill (*Balaeniceps rex*), 2 saddle-billed storks (*Epihippiorhynchus senegalensis*), and 8 bustards (*Houbara undulata*), from Port Said, Egypt; 2 Dow's tanagers (*Tangara dowi*), from Costa Rica; and 2 red-headed tanagers (*T. cayana*), 3 Desmarest's tanagers (*T. desmaresti*), 1 black-headed tanager (*T. atricapilla*), and 8 black-and-green tanagers (*T. nigriviridis*), from Venezuela.

CONSERVATION OF ALASKAN WILD LIFE

The principal amendments to the regulations for the 1933–34 season under the Alaska Game Law, published in April, afford greater protection for large brown and grizzly bears and moose and modify the trapping restrictions. Some of the recommendations of the Special Senate Committee on the Conservation of Wild Life Resources, notably those relating to the conservation of the large brown and grizzly bears, were incorporated in the revised regulations and other protective measures. This committee had issued a report in March 1932 on its study of conditions affecting this valuable resource of the Territory, in which special attention was given to methods and means of perpetuating the supply of big-game and fur animals.

As a result of appeals from interested conservationists, additional protection to large bears of several closely related species was afforded by extending the limits of an inviolate sanctuary where these superb carnivores may roam unmolested. The added sanctuary area embraces 1,910 square miles adjacent to and supplementing the Glacier Bay National Monument. The boundaries of the recently closed area follow closely those suggested for a national park in this region, and the combined closed area, including the monument, where the bears are now fully protected, contains approximately 3,730 square miles.

The amended regulations give further protection to large brown and grizzly bears by closing the season from June 20 to September 1 throughout the coastal ranges. In this region the seasonal bag for residents and nonresidents alike is restricted to two. The amendment safeguards the bears against unwarranted killing in summer, when their pelts are valueless for trophies.

Because of an unusual volume of publicity regarding the bears, an increasing number of people are apparently planning trips to the Territory to obtain trophies or to photograph the animals in their native haunts. For the safety of the uninitiated the regulation requiring that photographers, as well as hunters, be accompanied by registered guides has been clarified and continued in force.

Further protection of large brown and grizzly bears on Admiralty Island is contemplated in a game-management plan partly worked out by the Alaska Game Commission, the Forest Service, and the Bureau of Biological Survey during the year, to coordinate timber operations and bear protection. In connection with the development of this plan the Alaska Game Commission cooperated in taking a census of bears on the island, which resulted in much valuable information. The estimated aggregate population of the five species on this area is now 900.

Moose are afforded additional protection in southeastern Alaska by an amendment to the regulations that prohibits shooting on certain coastal islands, on which these animals take refuge during the breeding season. To provide a practical, well-defined boundary of the Kenai Moose Refuge, a part of the eastern side is made to follow natural watersheds and streams.

The Big Delta closed area for the protection of introduced buffalo was slightly reduced in response to appeals from local sportsmen. Without lessening protection to the buffalo, this will permit other uses of the area eliminated.

Few changes were made in regulations respecting fur-bearing animals, the principal one providing an extension of the open season on beaver to May 10 except in districts 1, 3, and 8, where no season was provided. Adverse economic conditions, with declining fur prices, have affected many of the trappers in the Territory. Trapping restrictions were therefore liberalized to afford residents the maximum benefits consistent with proper maintenance of the breeding stocks of the various species.

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